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THE

MALAYAN AGRICULTURAL JOURNAL

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MINISTRY OF AGRICULTURE, FEDERATION OF MALAYA.
Kuala Lumpur.

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(**Continued**)

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THE MALAYAN AGRICULTURAL JOURNAL

The Journal is designed to present—as far as possible in non-technical terms—the results of the agricultural research, investigation and extension work in Malaya performed by the Department of Agriculture. Also, by means of selected articles, abstracts and reviews, this publication draws attention to the results of work of a similar nature in other countries, which have a bearing on agriculture in Malaya.

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THE

Malayan Agricultural Journal

Vol. 39, No. 1, 1956.

EDITORIAL

Padi Experiments and Investigations. The Department of Agriculture is unceasing in its efforts to increase the rice crop in Malaya by selection and breeding of improved varieties, the use of fertilisers, soil surveys of potential padi areas, improved methods of cultivation (including double cropping), and pest and disease control. Much headway has been made since the second World War but often Malaya's unpredictable weather or the farmers' preoccupation with the country's chief economic crop, rubber, has nullified the knowledge acquired by the Department and passed on to the farmer.

This issue of the Journal contains three articles dealing with the Department's work on padi. In the first article the wet padi manurial investigations carried out between 1951 and 1955 are described. The second article, by the Acting Senior Entomologist, describes the rearing, in the laboratory at Kuala Lumpur, and liberation, in a double cropping area of Province Wellesley, of Tachinid parasites of padi stem-borers. Unfortunately the parasite has not been recovered. The third article gives an account of investigations into double cropping of wet padi in Province Wellesley.

Bulletins of the Department. It has been decided that in future Bulletins will be issued in one series, the series to commence with Bulletin No. 101. Bulletin No. 101 has been published and bears the title "Pot Experiments on the Insecticidal Control of Padi Stem-Borers".

The last Bulletins to be issued in the series now discontinued were:—Scientific Series No. 26; General Series No. 32; Economic Series No. 15; and Mechanisation Series No. 1.

WET PADI MANURIAL EXPERIMENTS IN MALAYA

BY

E. F. ALLEN,
Senior Agronomist,
and
R. HENDERSON, M.C.,
Agricultural Officer.

Introduction.

Padi manurial investigations were last reviewed after the 1950-51 season (1) and results from that harvest made it possible to design a fresh series of experiments for the 1951 to 1955 period. Some of these experimental designs were based on a report by Dr. E. W. Russell (8) while others were logical developments of earlier trials.

The Ecological Background.

Work on the classification of Malayan padi soils, which is now in progress, has not yet made it possible to correlate response to fertiliser with soil type (3). Nevertheless, a provisional classification has been attempted (2) and this is reproduced below for ease of reference:—

REGION	CLIMATIC ZONE	SOIL TYPE	CULTIVATION
Kedah-Perlis	N-E Monsoonal	Marine Alluvium	By plough
North-East Coast	N-E Monsoonal	Flood Plain River Alluvium	By plough
Port Dickson-Malacca	S-W Monsoonal	Marine Alluvium	By plough
Central	Equatorial	Marine Alluvium	
		(a) Bog soils	By hand
		(b) Clays	By hand
		(c) Sandy clays and loams	Mostly by plough
		River Valley Alluvium	
		(a) Bog soils	By hand
		(b) Clays and loams	Free-drained areas by plough; the rest by hand.

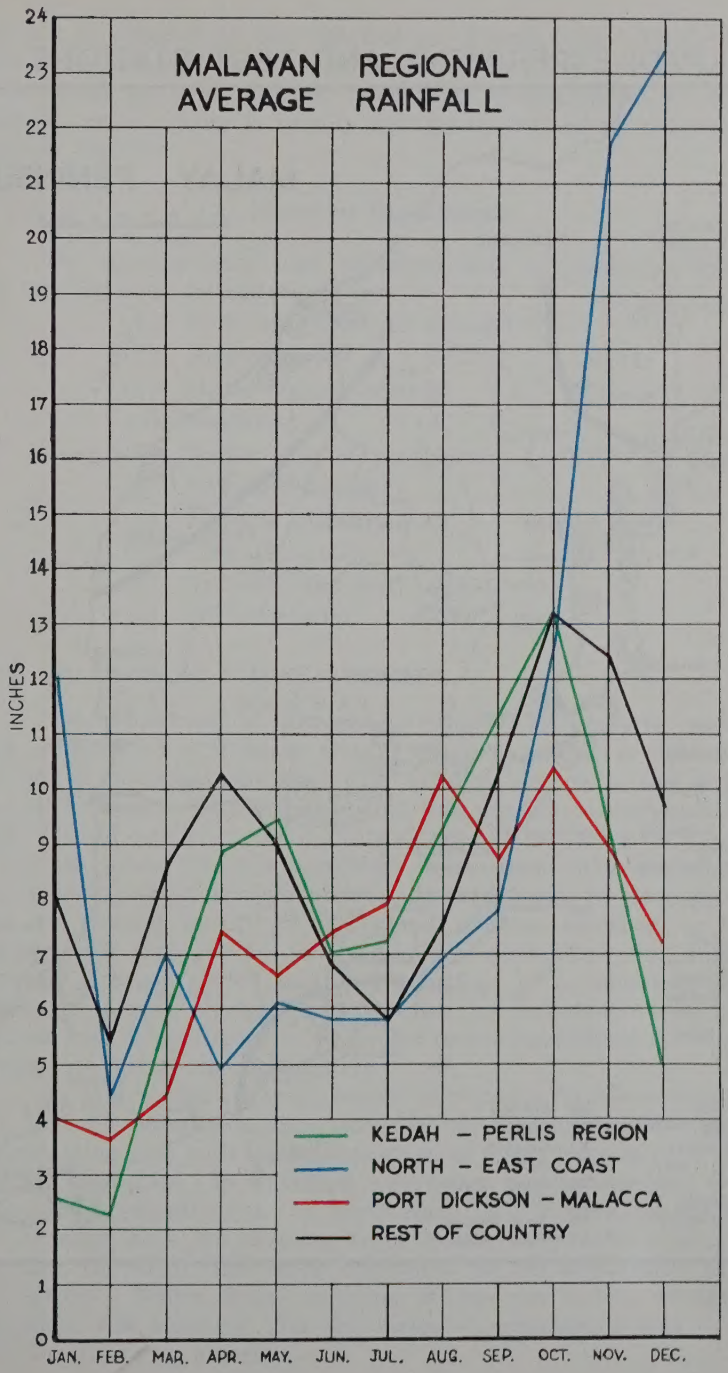
This classification is somewhat over-simplified and it ignores soil types of limited distribution, such as the bog soils of the east coast, which occur in association with coarse sandy, raised beaches. Similarly, the different regions are not always easy to delineate accurately, there being intermediate zones in north-west Perak, Province Wellesley and east Pahang.

The regional average rainfall is shown in Fig. I.

The localities of all important Padi Experiment and Test Stations are shown in the map, as are the approximate regional boundaries,

It is only north of a latitude of about 4° 30'N that the climate is normally sufficiently seasonal to permit harvesting in dry weather,

Fig. I.


MALAYAN REGIONAL
AVERAGE RAINFALL
INCHES
0
1
2
3
4
5
6
7
8
9
10
11
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13
14
15
16
17
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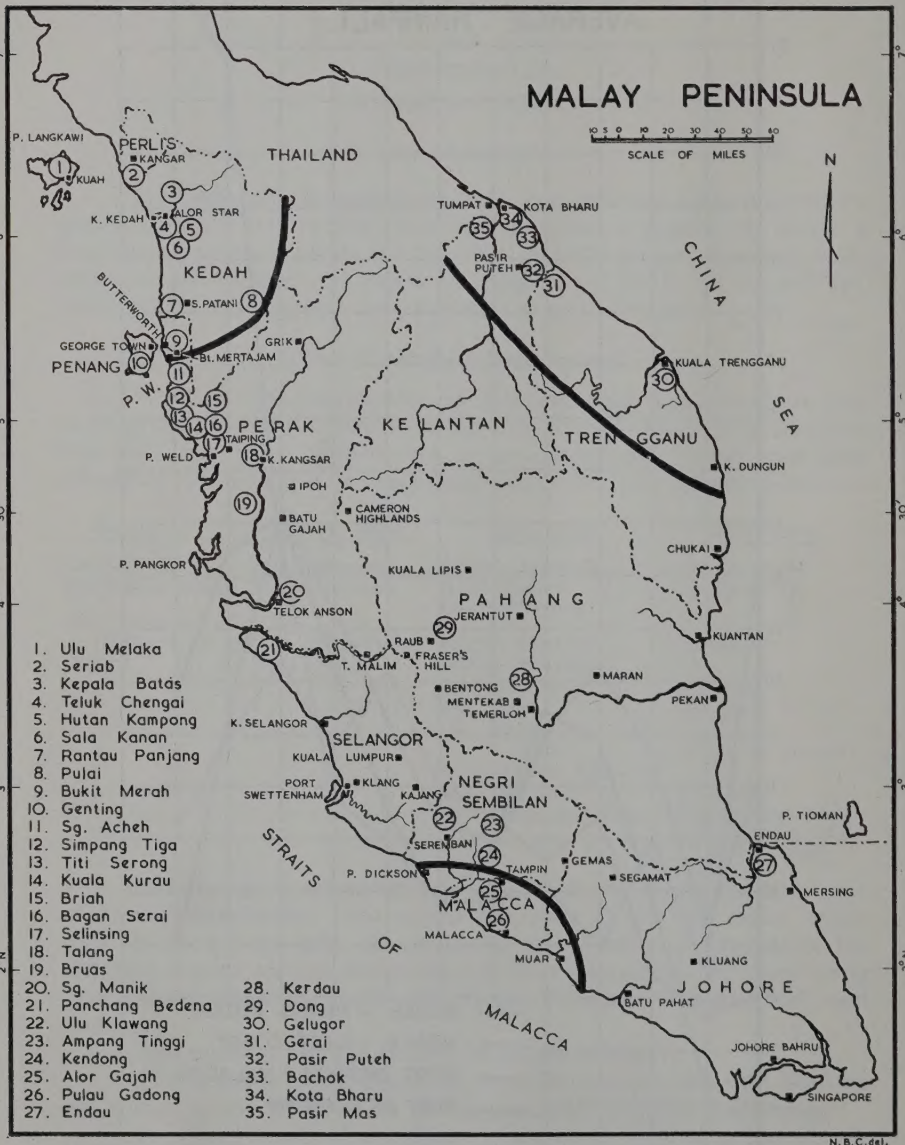
JAN.
FEB.
MAR.
APR.
MAY.
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
KEDAH – PERLIS REGION
NORTH – EAST COAST
PORT DICKSON – MALACCA
REST OF COUNTRY

PADI EXPERIMENT AND TEST STATIONS



and this is reflected in the distribution of padi land. Yields further south show considerable seasonal variation and even where proximity to the coast provides a more favourable micro-climate, as in north Selangor, grain quality is usually inferior to that which obtains in the northern regions.

Manurial Experiments.

The investigations here described may conveniently be divided into ten series as follows:—

(1) Type and depth of nitrogen;
(2) Ammophos;
(3) Mixed major elements;
(4) Sulphate;
(5) Kedah type of phosphate;
(6) Russell phosphate;
(7) Nursery manurial;
(8) Time of application;
(9) Varieties and fertilisers;
(10) NPK factorial.

TYPE AND DEPTH OF NITROGEN SERIES.

The placement of nitrogen fertilisers, particularly ammonium ones, is standard practice in certain countries as this is said to avoid the loss of nitrogen associated with broadcasting on to the surface of the soil or water. The theory behind this practice is now well known: under flooded conditions there exists a thin oxidised layer on the surface of the soil below which is a reduced layer where micro-organisms live anaerobically; if ammonium nitrogen is introduced, by deep placement, into the reduced zone it is stable and remains adsorbed by the soil colloids until taken up by the padi plant; where, however, ammonium nitrogen is broadcast on to the soil surface it is rapidly oxidized to nitrate or nitrite nitrogen which, when leached downwards into the reduced zone, is denitrified by anaerobic micro-organisms and the gaseous nitrogen is lost to the atmosphere.

In Japan, where deep placement of nitrogen fertilisers is advocated (6), it is the practice to apply some 70 per cent of the dressing before transplanting (5), with the balance given as a top dressing after effective tillering has ceased. In Malaya, however, best results have been obtained, with certain exceptions in the North-East Coast Region, by applying all the nitrogen as a top dressing from four to eight weeks after transplanting, the exact time being dependent on the maturation period of the variety. Under these conditions it was not known whether deep placement was beneficial and this series of experiments was laid down with the following objects:—

(a) to test the relative efficiency of sulphate of ammonia and nitrate of soda; and

(b) to compare broadcasting of the fertilisers with placement in the reducing zone, about 4 in. below the surface.

The treatments were as follows:—

A. Nitrate of soda broadcast on soil surface after draining off water;

B. Nitrate of soda placed by hand 3 to 5 in. below soil surface;

C. Sulphate of ammonia broadcast as in A;

D. Sulphate of ammonia placed as in B;

E. Control—no nitrogen.

The rate of application was 50 lb. nitrogen per acre and in all but two trials this was applied about eight weeks after transplanting. At Talang, in Perak, and Gerai, in Trengganu, the time of application varied from four to eight weeks after transplanting.

All experiments were manured with a basal dressing of phosphate comprising 67 lb. per acre P_2O_5 as double superphosphate (40 per cent P_2O_5) and the Kendong, Negri Sembilan, trial, which was situated on a sandy soil, was given a heavy potash dressing in addition.

In all cases the experimental layout consisted of a 5 x 5 latin square laid down at 14 localities and repeated, on the same sites, for two or three seasons.

Yields of grain and treatment effects are summarized in Table I, grouped according to regions. It will be seen that in six out of 14 localities there was a highly significant response to nitrogen, the mean effect varying from 254 to 656 lb. per acre. At three of these localities, namely Telok Chengai and Hutan Kampong, in Kedah, and Gerai, sulphate of ammonia proved to be markedly superior to nitrate of soda. Only at Hutan Kampong was there a significant difference between methods of application, and this favoured broadcasting on the surface. At this station there was a marked build up of control yields and it seems possible that some of the residual nitrogen left in the soil after the first season was spread during cultivation. Clearly it would have been preferable to have re-sited the trials on fresh land each season but availability of land precluded this.

The two Kelantan trials were unmanured in the third season and an interesting effect was noted at Pasir Puteh where all manuring in the previous two seasons depressed residual yields except where nitrate of soda had been placed in the soil. The large interaction was just significant and should perhaps be treated with reserve.

It is interesting to note that the highest mean yields, those at Telok Chengai and Kuala Kurau, are associated with two of the three highest responses to nitrogen. This perhaps indicates that this nutrient is only a limiting factor of yield when other conditions of growth are good; certainly such an hypothesis agrees well with observations in the field.

It is also perhaps significant that of the six stations which showed a consistent response in yield to nitrogen, four are rain fed, only Bukit Merah, in Province Wellesley, and Kuala Kurau, in Perak, being irrigated. Conversely, of the eight localities where there was no positive response to nitrogen, all except Pasir Puteh are irrigated and these stations perhaps receive appreciable nitrogen in irrigation water. This point deserves further study.

At Selinsing, Perak, it has been demonstrated that lateral drift occurs even when nitrogen is placed in the soil, and a similar source of error may exist at other irrigated localities. Certainly, experimental error was excessively high at Talang in the first two seasons, the coefficient of error variation (C.V.e) being 34.3 and 29.0 per cent respectively.

The superiority of ammonium over nitrate nitrogen at three stations agrees well with theory but the results show no advantage from deep placement. Two factors may account for this result: firstly, it is extremely difficult in practice to broadcast a fertiliser on to the soil surface without some trampling afterwards and this would inevitably reduce the effective difference between the two methods of application; secondly, since all nitrogen was applied as a top dressing at a time when root spread of the padi clumps must have achieved their maximum development, then conditions in the soil clearly favour a rapid uptake by the plants. At the same time, active decomposition of organic residues in the soil must by this time have become of less importance, so losses from denitrification would be less likely to occur.

Conclusions.

(1) Nitrogen was effective in increasing yields in six out of 14 localities.

(2) Sulphate of ammonia was superior to nitrate of soda in three of these localities and was nowhere inferior.

(3) Broadcasting was superior to placement in the soil at Hutan Kampong but method of application was not important elsewhere. Broadcasting is to be preferred, therefore, in rain-fed padi land where there is no lateral water movement. In irrigated areas, where lateral nutrient drift may occur, some form of placement would seem advisable. A convenient method of application would be to drain off the irrigation water, close the outlets, broadcast the fertiliser on to the soil surface and to mix it well, either by trampling or by carrying out weeding.

(4) In no case was there a significant interaction between methods of application and type of nitrogen in the year of fertiliser application. The residual interaction noted in 1954 at Pasir Puteh was associated with low yields and some rat damage.

(5) Since sulphate of ammonia is a cheaper source of nitrogen than nitrate of soda it will remain the preferred type.

AMMOPHOS SERIES.

The object of this series of experiments was to compare the relative efficiency of Ammophos fertilisers containing mono-ammonium phosphate (12 : 61 = N : P_2O_5 per cent) and sulphate of ammonia with equivalent mixtures of double superphosphate and sulphate of ammonia. The Ammophos fertilisers were supplied free by Messrs. Albatros Superfosfaatfabricken N.V., of Utrecht, at whose request the trials were laid down.

The treatments were as follows:

	BEFORE PLANTING	EIGHT WEEKS LATER
A.	16 : 20 Ammophos (32 lb.N + 40 lb. P_2O_5 per acre)	sulphate of ammonia (18 lb. N per acre)
B.	Sulphate of ammonia + double superphosphate (32 lb. N + 40 lb. P_2O_5 per acre)	as A
C.	11 : 48 Ammophos (9 lb. N + 40 lb. P_2O_5 per acre)	sulphate of ammonia (41 lb. N per acre)
D.	Sulphate of ammonia + double superphosphate (9 lb. N + 40 lb. P_2O_5 per acre)	as C
E.	Control—no fertiliser	

All A, B, C and D plots received a basal dressing of 15 lb. per acre of K_2O as muriate of potash.

It will be seen that a comparison between A + B and C + D provided a test of the effects of most of the nitrogen being supplied early or late.

In most of the trials the manured plot size was 22 x 22 ft. and the recorded size 20 x 20 ft., so the effective discard between treatments measured 2 ft. The layout was a 5 x 5 latin square or five randomized blocks.

The trial was laid down in eight localities in 1952, but one of these was subsequently abandoned because of flood damage. It was continued for three seasons at seven localities.

Harvest results are summarised in Table II.

Consolidated analyses show that there was a consistent response to fertiliser at only two stations, namely, Ulu Melaka, in Kedah, and Bukit Merah. There was no overall difference between the two types of fertiliser nor between the two distributions in time. There was, however, a superiority shown at Selinsing of Treatment B over C, A and Control. This is somewhat difficult to account for but may be associated with a high rate of flow of water through this station. It may be that the late nitrogen was more easily washed out of the soil; the result is somewhat suspect because a nutrient drift of 11 ft. was noticed in January, 1954, one month after the nitrogen top dressing had been applied.

Table I.

Type and Depth of Nitrogen Series.

Yields of Grain.

(lb. per acre)

Expt. No.	Place	Season	Nitrate of Soda		Sulphate of Ammonia		No N	Resp. to N/S	Resp. to S/A	Broadcast minus Sub-Surface	Interaction	Remarks
			Broadcast	Sub Surface	Broadcast	Sub Surface						
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.												
K/P. 48	Telok Chengai	51-52	3263	3185	3520	3422	2870					
		52-53	4098	4064	4384	4355	4053					
		53-54	4267	4340	4331	4296	4090					
			3876	3863	4078	4024	3671	198	380	34	— 20	Rain-fed †
K/P. 48	Hutan Kampong	51-52	2040	2034	2685	2585	1458					
		52-53	2593	2355	2839	2759	1963					
		53-54	2770	2603	2860	2741	2328					
			2467	2331	2795	2695	1916	483	829	118	18	Rain-fed †
BM.21/51	Bukit Merah	51-52	2345	2395	2251	2306	2078					
		52-53	2006	2030	2095	2184	1853					
		53-54	1985	1961	1951	2035	1694					
			2112	2129	2099	2175	1875	246	262	— 46	30	Irrigated †
N.E. COAST REGION.												
Kn. 79	Pasir Mas	51-52	408	476	429	484	368					Dry year
		52-53	2682	2842	2934	3027	2192					
			1545	1659	1682	1756	1280	322	439	— 94	— 20	Rain-fed †
		53-54	1380	1419	1310	1336	1418	— 18	— 95	— 32	— 7	Residual. Japonica padi
Kn. 85	Pasir Puteh	51-52	2310	2148	2229	2140	2194					
		52-53	3294	3300	3450	3414	3282					
			2802	2724	2840	2777	2738	25	70	70	8	Rain-fed
		53-54	934	1326	951	771	1020	110	— 159	— 106	— 286	Residual. Rat damage
Tr. 17	Gerai	51-52	375	530	583	610	331					* Leptocorisa damage
		52-53	2179	2130	2442	2403	1822					

			1277	1330	1513	1506	1077	226	432	— 23	— 30	Rain-fed †
CENTRAL REGION.												
Pk.N.4/51	Selinsing	51-52	1569	1614	1712	1732	1772					
		52-53	1926	1892	1911	1706	1710					
		53-54	2166	2325	2172	2310	2508					
			1887	1944	1932	1916	1996	— 80	— 72	— 20	— 36	Irrigated
Pk.N.6/51	Briah	51-52	1800	1632	1620	1761	1704					
		52-53	1250	1347	902	990	1257					
		53-54	957	927	741	693	878					
			1336	1302	1088	1148	1280	39	— 162	— 13	47	Irrigated
Pk.N.10/51	Kuala Kurau	51-52	3510	3624	3842	3705	3186					
		52-53	4296	4284	4350	4380	4020					
		53-54	4920	5004	4844	4659	4010					
			4242	4304	4345	4248	3738	535	558	18	— 80	Irrigated †
Pk.C.7/51	Bruas	51-52	1192	1432	1023	993	1210					
		52-53	2790	2382	2742	2508	2670					
		53-54	2334	2486	2386	2238	2002					
			2106	2100	2050	1913	1961	142	20	72	— 66	Irrigated
Pk.C.10/51	Talang	51-52	1315	1392	1205	1526	1651					(high error)
		52-53	2420	2390	3000	2600	2220					(high error)
		53-54	2382	2202	2562	2274	2052					
			2039	1995	2256	2133	1974	43	220	84	— 40	Irrigated
Pk.S.6/51	Sungei Manik	51-52	2538	2352	2286	2220	2586					
		52-53	1302	1146	1068	1398	1314					
		53-54	2784	2874	2754	2550	2826					
			2208	2124	2036	2056	2242	— 76	— 196	32	52	Irrigated (poor drainage)
NS. 36	Kendong	52-53	3201	3294	3500	3273	3239					
		53-54	3177	3050	3156	3246	3074					
		54-55	2892	3029	3027	2970	3024					
			3090	3124	3228	3163	3112	— 5	84	16	— 50	Irrigated
W.Phg. (R) 13 & 24	Dong	51-52	616	786	498	542	806					Severe lodging
		52-53	3764	3852	3736	3651	3663					Adjusted
			2190	2319	2117	2096	2234	20	— 128	— 54	— 75	Irrigated

† Response to nitrogen highly significant.

* Empty grain.

Conclusions.

(1) There was a consistent positive response to fertiliser in two localities out of seven.
(2) Ammophos fertilisers showed no consistent superiority or inferiority over comparable mixtures of sulphate of ammonia and double (40 per cent P_2O_5) superphosphate.
(3) At Selinsing, where lateral water movement is sometimes excessive, a mixture of sulphate of ammonia and superphosphate, with 80 per cent of the nitrogen applied before planting, proved to be superior to both types of Ammophos.
(4) At the time of writing (October, 1955) Ammophos 11:48 is a cheaper source of soluble nutrients than an equivalent mixture of sulphate of ammonia and double superphosphate. It is available in granular form at no extra cost.

MIXED MAJOR ELEMENT SERIES.

The object of this series of trials was to test the effect of NPK in the absence of sulphates and in the presence and absence of calcium and magnesium on the growth, yield and nutrient uptake of wet padi.

The treatments were as follows:—

A. NPK + Ca;
B. NPK + Mg;
C. NPK + Ca + Mg;
D. NPK;
E. Control—no fertiliser.

Nutrients were applied in the following rates and forms:—

NUTRIENT	RATE OF NUTRIENT PER ACRE	FERTILISER
N	45 lb.	(Urea (Mono-ammonium phosphate
P_2O_5	40 lb.	Mono-ammonium phosphate
K_2O	50 lb.	Muriate of potash
CaO	50 lb.	Ground limestone
MgO	50 lb.	Magnesium carbonate

The potash, calcium and magnesium fertilisers were applied just before transplanting and puddled or cultivated into the soil. The urea and ammonium phosphate were placed in the soil, by hand plunging, about eight weeks afterwards.

The layout adopted was a 5 x 5 latin square and it was laid down at eight localities on the same site each season. Particular care was taken to avoid using sulphate-containing fertilisers such as single superphosphate or sulphate of ammonia as it had been suggested by Russell (8) that earlier failures to obtain a fertiliser response from Malayan padi crops might have been associated with root injury caused by the reduction of sulphate in the soil to sulphides.

Yields of grain from this series are summarized in Table III. There was a significant response in yield from NPK at five of the eight stations, the mean response being 467 lb. per acre at the five localities. There was no general response at Bruas and Sungei Manik, in Perak, or Dong, in Pahang, although an individual response was noted at Sg. Manik in the 1951-52 season.

The effect on yield of the divalent bases was disappointing and the only result which achieved statistical significance was a negative response to magnesium in the presence of NPK at Ulu Klawang, Negri Sembilan. This effect is best ignored since the level of significance was only 5 per cent and one such chance result could reasonably be expected since 24 separate tests were made in the overall series analyses.

The large negative interaction of −229 lb. per acre observed at Kuala Kurau was non-significant, the relevant standard error being ± 97.290.

During the course of this investigation a very large number of straw and grain samples was collected as well as samples of green leaves at the time of flowering. These were analysed for nitrogen and ash on an oven-dry basis and for P_2O_5, K_2O, CaO and MgO on the ash. It would be out of place to consider detailed results in this paper and they will receive separate treatment.

Conclusions.

(1) There was an overall positive response in yield of grain to an NPK fertiliser at five out of eight stations, the mean effect being + 467 lb. of grain per acre.

(2) At one locality, magnesium depressed yield of grain in the presence of NPK. No effect was noted elsewhere.

(3) Calcium had no effect on grain yield at any locality.

SULPHATE SERIES.

The object of this series was to discover if the application of sulphate to the soil had any harmful effect on the growth and yield of wet padi. The treatments were suggested by Russell (8) for the reason noted in the section on the Mixed Major Elements Series. The actual treatments were as follows:—

A. 336 lb. per acre of calcium sulphate;
B. Calcium chloride containing the same quantity of calcium;
C. Calcium carbonate containing the same quantity of calcium;
D. Control—no fertiliser.

The experiment was put down at six localities with a layout of six randomized blocks. The three calcium salts were applied just before transplanting and puddled or cultivated into the soil. With one exception, no other fertiliser was applied: the exception was at Pulau Gadong, Malacca, where a 30 : 30 : 15 lb. per acre application was given of $N : P_2O_5 : K_2O$ in the 1953-54 season only. Sites remained unchanged in the three seasons.

Table III.

Mixed Major Elements Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Year	A NPK Ca	B NPK Mg	C NPK CaMg	D NPK	E Control	NPK vs Control	Ca	Mg	CaMg	Remarks
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.												
BM.19/51	Bukit Merah	51-52	2633	2539	2561	2498	2165					
		52-53	2028	2278	1999	1992	1574					
		53-54	1817	1841	1939	1805	1526					
			2157	2219	2166	2098	1755	406	4	64	— 57	Irrigated
N.E. COAST REGION.												
Kn. 78	Kota Bharu	51-52	2232	2140	2272	2272	1717					
		52-53	2448	2480	2457	2588	1871					
			2340	2310	2365	2430	1791	571	— 17	— 48	73	Irrigated
MALACCA REGION.												
M. 33	Pulau Gadong	51-52	2541	2732	2836	2650	2430					
		52-53	2736	2800	2722	2709	2440					
		53-54	2614	2566	2780	2451	2418					
			2630	2700	2780	2604	2430	249	54	122	26	Irrigated
CENTRAL REGION.												
Pk.N 8/51	Kuala Kurau	51-52	4176	4344	4440	4032	3576					
		52-53	4896	5016	4788	4626	4464					
		53-54	4864	4798	4396	4437	4442					
			4646	4720	4542	4365	4160	407	51	125	—229	Irrigated
Pk.C. 6/51	Bruas	51-52	834	916	754	1020	951					*Scotinophara* damage
		52-53	1602	1356	1344	1647	1602					*Sogata* damage
		53-54	1628	1578	1608	1534	1556					*Scotinophara* damage
			1354	1284	1236	1400	1370	— 51	— 47	—118	— 1	Irrigated
Pk.S. 5/51	Sungei Manik	51-52	1680	1698	1842	1752	1512					
		52-53	2298	2278	2376	2276	2316					
		53-54	2496	2586	2522	2592	2574					Lodging general
			2158	2188	2246	2206	2134	66	5	35	54	Irrigated
NS. 33	Ulu Klawang	52-53	2672	2544	2311	2569	2013					
		53-54	4423	4314	3874	4400	3478					
		54-55	3655	3857	3659	3836	2935					
			3583	3571	3281	3601	2809	701	—154	—166	—136	Irrigated
W.Phg. (R) 14	Dong	51-52	1188	982	1010	1227	1017					
		52-53	3494	3527	3456	3510	3373					Adjusted for bird damage
			2341	2251	2233	2367	2199	100	— 22	—112	4	Irrigated

Table IV.

Sulphate Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Year	A Calcium Sulphate	B Calcium Chloride	C Calcium Carbonate	D Control	Sulphate Effect	Calcium Effect	Remarks
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.									
K/P. 46	Telok Chengai	51-52	2716	2682	2798	2844			
		52-53	3494	3331	3419	3219			
		53-54	3424	3283	3358	3294			
			3211	3098	3192	3119	66	48	
BM. 20/51	Bukit Merah	51-52	2130	2370	2140	1792			
		52-53	1940	2050	1920	1792			
		53-54	1790	1728	1830	1622			
			1953	2049	1963	1735	— 53	253	
MALACCA, PORT DICKSON REGION.									
M. 34	Pulau Gadong	51-52	1640	1612	1666	1460			
		52-53	1729	1718	1849	1674			
		53-54	1718	1619	1704	1801			Manured with NPK
			1695	1650	1740	1644	0	51	
CENTRAL REGION.									
Pk.N.9/51	Selinsing	51-52	720	720	760	640			
		52-53	1570	1890	1880	1840			
		53-54	2000	2140	1990	1870			
			1429	1585	1545	1448	— 136	72	
Pk.C.4/52	Bruas	52-53	1580	1495	1430	1745			
		53-54	2272	2424	2410	2284			
			1926	1959	1920	2014	— 14	— 79	
Pk.S.4/51	Sungei Manik	51-52	1280	1100	1150	1470			
		52-53	2280	2500	2310	2400			
		53-54	2480	2460	2170	2440			
			2017	2020	1877	2102	68	— 131	

The three Perak localities in the Central Region were selected because they all suffered from impeded drainage during the early post-war years and it was known that they all had a history of failure to respond to fertiliser. Pulau Gadong was selected since the soils there have a high sulphur content before reclamation.

The results are summarized in Table IV. In no case was a significant effect of sulphate demonstrated, not even at Selinsing in the 1952-53 season. However, there was a significant response in yield from calcium in all years at Bukit Merah and in the first season at Pulau Gadong. In the second season, 1952-53, calcium carbonate was also of benefit at Pulau Gadong.

This response to calcium is of very considerable interest, especially when it is remembered that the application of CaO was equivalent to only 138 lb. per acre and that the two stations where the effect was demonstrated were situated some 240 miles apart. It was of particular interest that no such beneficial effect of calcium was demonstrated in the presence of NPK either at Pulau Gadong in the 1953-54 season or in the Mixed Major Elements Series.

A small beneficial effect of calcium carbonate could be ascribed to increased availability of ammonium nitrogen as a direct result of mineralisation of the easily decomposable soil organic matter; but this would not explain a comparable effect of calcium sulphate and chloride since both are salts of strong acids and their net effect on soil reaction would be to reduce the pH.

A possible explanation of this result is the known effect of calcium salts in stimulating nitrogen fixation by blue green algae. Many workers have observed that such fixation is increased when calcium carbonate is added to the soil but Singh (9) has noted that both calcium sulphate and chloride increase such fixation, although to a lesser extent than the carbonate. Kanapathy has also described how gypsum stimulates algal growth under waterlogged conditions (4) but he ascribed this effect to the sulphur.

It might be argued that this is a simple calcium effect but if it were so it could also be expected in the presence of NPK unless ion antagonism inhibited calcium uptake. Further speculation is perhaps not justified in the absence of fresh experimental data: certainly the effect is of academic interest only since comparable quantities of calcium are applied to padi soils in such phosphatic fertilisers as rock phosphate and the superphosphates.

Conclusions.

(1) No harmful effect of adding sulphates to the soil over a three-year period has been demonstrated.

(2) In the absence of NPK fertilisers small applications of calcium salts may sometimes lead to an increase in grain yield. This was observed at two localities—one in the first season only, the other in all three seasons.

KEDAH TYPE OF PHOSPHATE SERIES.

The object of this series was to compare the relative efficiency of soluble (40 per cent superphosphate) and insoluble (Christmas Island rock phosphate and local bat guano) sources of P_2O_5. Earlier micro-plot trials (1) had shown that the soluble form was usually much more efficient than insoluble ones, but this result had been obtained with placement methods and very large applications of P_2O_5. Furthermore, doubt had been cast on the universal application of this particular result by practical experience with high quality bat guanos in the Kedah-Perlis region.

The standard layout was one of six randomized blocks but there were 12 replications at Gerai. Treatments were as follows:—

A. 100 lb. per acre P_2O_5 as bat guano;
B. 100 „ „ „ „ „ double superphosphate (40 per cent P_2O_5);
C. 100 „ „ „ „ „ Christmas Island rock phosphate;
D. Control, no phosphate.

Local bat guanos are usually fossil ones which contain virtually no nitrogen. Their P_2O_5 content is highly variable but machine-mixed supplies of known analysis are available in north Kedah. Typical good quality samples contain 12 to 16 per cent P_2O_5.

Christmas Island rock phosphate is a finely ground product and is the cheapest locally available phosphatic fertiliser. It has a P_2O_5 content of 37 per cent. Experience with permanent crops in Malaya has shown that it becomes available to the crop with surprising rapidity, a fact which is the easier to accept when the local background of acid soils, uniformly high temperatures and high humidities is made known.

All phosphatic manures were applied before transplanting and later cultivated or puddled into the soil. The trials were repeated on the same site each season with phosphate applications repeated everywhere except at the three N.E. Coast stations in the 1953-54 season.

Top dressings of nitrogen were given to most of the experiments but the actual quantities varied from station to station. In addition, basal dressings of potash were applied before transplanting at the three N.E. Coast stations in the 1952-53 season and repeated the following season at the two Kelantan stations.

Yields of grain and details of nitrogen top dressings are summarized in Table V.

A significant response to phosphate was demonstrated as an overall effect at six out of the 15 localities. At some of the other stations there were individual responses in certain years as at Ulu Klawang in the 1954-55 season. The large response at Hutan Kampong ties up well with the known fact that this station had received no fertiliser for many years whereas the other stations in the Kedah-Perlis Region had a history of regular triennial applications of bat guano.

The very large residual effect recorded in the 1953-54 season at Pasir Mas, Kelantan, is of considerable interest.

Table V.

Kedah Type of Phosphate Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Year	100 Lb. P_2O_5/Acre at Transplanting			No P_2O_5	Effect of Phos-phate	Soluble minus Insoluble	Remarks	Basal Dressing
			Bat Guano (A)	Double Super (B)	C.I.R.P. (C)	(D)				
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.										
K/P. 47	Telok Chengai	51-52	3371	3371	3395	3289				
		52-53	4026	4211	4101	4085				50 lb.N/acre—6 weeks after transplanting
		53-54	3790	3907	3891	3770				50 lb.N/acre—8 weeks - do -
			3729	3829	3796	3715	70	66		
K/P. 47	Hutan Kampong	51-52	2733	2680	2831	2194				101 lb.N/acre— 8 weeks after transplanting
		52-53	2998	3139	3020	2291				50 lb.N/acre— 8 weeks - do -
		53-54	2921	3027	2951	2577				50 lb.N/acre—55 days - do -
			2884	2949	2934	2354	568xxx	40		
K/P. 47	Seriab	52-53	2725	2756	2766	2889				50 lb.N/acre
		53-54	1991	2183	1964	2232				50 lb.N/acre
		54-55	3105	3155	3115	2887				50 lb.N/acre
			2607	2698	2615	2669	— 29	87		
K/P. 47	Sala Kanan	52-53	4321	4491	3957	4165				50 lb.N/acre 33 days after transplanting
		53-54	1920	1892	1933	2026			Rat damage & *penyakit merah*	50 lb.N/acre 50 days - do -
			3121	3191	2945	3095	— 9	158		
K/P. 47	Rantau Panjang	52-53	3444	3231	3320	3181				50 lb.N/acre
		53-54	2972	2989	2932	3007				50 lb.N/acre 60 days - do -
			3208	3110	3126	3094	54	— 57		
K/P. 47	Pulai	52-53	4200	4273	4170	4650				50 lb.N/acre 52 days - do -
		53-54	4054	4203	4015	4025				50 lb.N/acre 53 days - do -
			4127	4238	4092	4337	—185	128		
K/P. 47	Ulu Melaka	52-53	862	952	708	893				50 lb.N/acre 58 days - do -
		53-54	1927	1914	1856	1479				50 lb.N/acre 54 days - do -
		54-55	1407	1343	1391	1100				50 lb.N/acre 54 days - do -
			1398	1403	1318	1157	216xxx	45		
Pg. 4/52	Bukit Merah	52-53	2025	2091	2089	1759				50 lb.N/acre 48 days - do -
		53-54	1981	2040	2009	1715				50 lb.N/acre 45 days - do -
			2003	2066	2049	1737	302xxx	40		
Pg. 4/52	Genting	52-53	1760	1948	1679	1494				50 lb.N/acre 54 days - do -
		53-54	2355	2398	2205	1870			Phos. applied 51 days after	50 lb.N/acre 56 days - do -
			2058	2172	1942	1682	375xx	172		
N.E. COAST REGION.										
Kn. 80	Pasir Mas	51-52	194	212	185	203			Very dry season	
		52-53	2538	2965	2851	2152				30 lb. K_2O/acre. 50 lb.N/acre 54 days after transplanting
			1366	1588	1518	1177	314xx	146		
		53-54	1340	1404	1166	668	635xxx	151x	Residual	30 lb. K_2O/acre. 50 lb.N/acre 45 days after transplanting
Kn. 84	Pasir Puteh	51-52	2392	2114	2610	2276				
		52-53	3721	3443	3317	3415				30 lb.K_2O/acre. 50 lb.N/acre 60 days after transplanting
			3057	2779	2963	2845	88	—231		
		53-54	3101	2790	2528	2525	281	— 24	Residual	30 lb.K_2O/acre. 50 lb.N/acre 61 days after transplanting
Tr. 18	Gerai	51-52	355	380	480	591			74% empty grain	
		52-53	2380	2370	2230	1689				30 lb.K_2O/acre. 50 lb.N/acre 6 weeks after transplanting
			1367	1375	1355	1140	226xx	14		
		53-54	644	641	712	432	234xxx	— 37	Residual. Lepto-corisa damage	50 lb.N/acre—6 weeks after transplanting
CENTRAL REGION.										
NS. 32	Ulu Klawang	52-53	2189	2194	1913	2021				
		54-55	3616	3763	3651	3477				
			4598	4717	4497	4104	sig.			47 lb.N/acre
			3468	3558	3354	3201	259	147		
NS. 35	Kendong	52-53	3365	3481	3373	3245				100 lb.N/acre 8 weeks after transplanting
		53-54	3186	3181	3020	2917				100 lb.N/acre 8 weeks - do -
		54-55	2875	2773	2906	2983				47 lb.N/acre
			3142	3145	3100	3048	81	24		
NS. 39	Ampang Tinggi	52-53	3099	3066	3230	3045				100 lb.N/acre 8 weeks after transplanting
		53-54	3284	3201	3326	3126				100 lb.N/acre 8 weeks - do -
		54-55	3377	3318	3333	3971				
			3253	3195	3296	3380	—132	— 80		

KEY: x Significant effect at the 5 per cent level. xx Significant effect at the 1 per cent level. xxx Significant effect at the 0.1 per cent level.

Table VI.

Kedah Type of Phosphate Series on Smallholders Land.

Mean Yields of Grain.

Season	Locality	Soil Type	Number of Sites	Mean Yield (lb./acre)	N.P. Effect (lb./acre)	Soluble-Insoluble Effect (lb./acre)	Remarks
1952-53	N. Kedah	Medium and light	20	3025	340 xxx	— 21	
„	„	Heavy	29	3735	237 xx	93	
„	P. Wellesley North		30	2312	279 xx	— 15	
„	„ Central		20	2485	248 xx	111 xxx	
1953-54	N. Kedah	Medium and light	46	3147	356 xxx	4	
„	„	Heavy	28	3316	249 xxx	— 36	
„	S. Kedah	Medium and light	19	2337	265 xxx	212 xx	
„	„	Heavy	6	3179	244 x	65	
„	Perlis	Medium and heavy	7	2757	127	189	
„	„	Light	18	2914	228 xxx	— 91	
„	Langkawi	Very sandy	13	1302	353 xxx	50	
„	Padang Terap	Sandy	12	1122	549 xxx	—	Only superphosphate tested
„	P. Wellesley North		22	2689	482 xxx	— 11	
„	„ Central		26	2170	309 xxx	16	
1954-55	P. Wellesley North		20	2251	477 xxx	— 71	
„	„ Central		26	1873	203 xxx	— 80	
		Total	342				

The general trend was for superphosphate to be superior to water insoluble phosphates but in no case was this overall effect significant. Only in its residual effect at Pasir Mas was the soluble fertiliser proved to be superior.

As a logical follow-up to this series of trials a similar but not identical series was laid down in the 1952-53 season on smallholders' land in Kedah, Perlis and Province Wellesley. These trials were repeated and increased in number in the following seasons, some being studied for residual effects. In all seasons the first-year treatments were as follows:—

A. 100 lb. P_2O_5 as bat guano + 30 lb. N as sulphate of ammonia;
B. 100 lb. P_2O_5 as rock phosphate + 30 lb. N as sulphate of ammonia;
C. 50 lb. P_2O_5 as double superphosphate + 30 lb. N as sulphate of ammonia;
D. Control—no phosphate or potash.

} per acre

Each replicate consisted of a four-plot block, the plot size being 33 x 33 ft. (1/40 acre). Method and time of application of the N.P. fertilisers were the same as in the main series of experiments.

Residual treatments varied from place to place in Kedah and Perlis and the 1954-55 effects have not yet been elucidated. However, first-year residual effects in the 1953-54 season were either non-existent or small. Thus, trials in Kedah on heavy soil revealed a phosphate residual effect of 31 lb. per acre, this being significant. On medium and light soils there was no effect. This was attributed only to the phosphate since all four plots had received a basal application of nitrogen.

The first-year effects for the three seasons are summarized in Table VI. It will be seen that in a series of 342 separate blocks a marked effect of N.P. fertilisers was demonstrated in 335 blocks. This effect ranged from 203 to 549 lb. of grain per acre. It was particularly gratifying to note that big responses were obtained even in high-yielding areas such as North Kedah.

Only in two groups of 39 blocks was the half dressing of superphosphate superior to the full dressing of water-insoluble phosphates. In all other cases no difference was demonstrated.

Conclusions.

(1) In the Kedah-Perlis Region a marked response to NP fertilisers can normally be expected.

(2) There is usually little to choose between the efficiency of soluble and insoluble forms of phosphate but 50 lb. of P_2O_5 as double superphosphate is at least as good as 100 lb. P_2O_5 in the water insoluble form.

(3) Both bat guano and Christmas Island rock phosphate are suitable padi fertilisers. The former is sometimes cheaper in Kedah and Perlis and is to be preferred locally; rock phosphate will be preferred in Province

Wellesley or in parts of Kedah which are some distance from a source of supply of bat guano.

(4) There are occasions when double superphosphate is undoubtedly superior to the insoluble fertilisers. It is certainly somewhat more rapidly available and it may be that only poorly-grown seedlings will benefit from this more expensive source of phosphate. If this hypothesis be proved correct, then the solution may be to manure nurseries with soluble phosphate.

RUSSELL PHOSPHATE SERIES.

Russell (8) had emphasised the importance of getting even a small quantity of phosphate into the padi plant at an early stage in its growth. It was decided, therefore, to compare different methods of applying phosphate to the padi crop, these methods ranging from seed-soaking, as practised by Roberts on oats (7), to different methods of nursery manuring and the placement application of heavy dressings in the field. This series was laid down at nine stations with the following treatments:—

A. Seed pre-soaked in potassium tri-basic phosphate solution at the rate of 1 lb. (anhydrous) per *gantang* (gallon) of seed;
B. The same quantity of potassium tri-basic phosphate (K_3PO_4) was applied to the nursery beds;
C. The nurseries manured with a very finely ground rock phosphate at the rate of 8 lb. (2 lb. P_2O_5) per gallon of seed;
D. 200 lb. per acre P_2O_5 as double (40 per cent) superphosphate placed in the soil eight weeks after transplanting;
E. As D but using basic slag;
F. Control—no phosphate.

Two amendments were found necessary during this experiment:—

(*i*) with effect from the second season at each station the time of placement application of D and E was changed to before transplanting. This corrected what was later realised to be a mistake in the layout; and

(*ii*) with effect from the 1953-54 season it was found impossible to obtain supplies of potassium tri-basic phosphate at a reasonable price so the approximate P_2O_5 equivalent of mono-ammonium phosphate was substituted (i.e. ½ lb. per one gallon of seed).

In the 1951-52 season all trials were top-dressed with 100 lb. per acre of nitrogen as sulphate of ammonia placed in the soil eight weeks after transplanting. In the second and third seasons all trials, except that at Talang, received, in addition, a basal dressing of 15 lb. per acre of K_2O as muriate of potash before transplanting. Also, in the second season the application of nitrogen was reduced to 50 lb. per acre at Telok Chengai because of widespread lodging in the previous season.

The method of seed treatment was to dissolve the 1 lb. of potassium tri-basic phosphate in water and to make this up to half a gallon.

One gallon of seed was soaked in this solution for 24 hours, kept damp for a further 24 hours and then sown in the ordinary way. Preliminary trials had shown that this did not seriously affect germination and that most of the solution was absorbed by the grain.

Seed for Treatments B to E was given a similar treatment before sowing but using water.

In Treatment B, the potassium phosphate was mixed with soil and then broadcast evenly over the nursery surface. It was then mixed well with the top one inch of soil before sowing the seed.

In Treatment C, 8 lb. of rock phosphate (26-27 per cent P_2O_5) was applied to the appropriate nursery area for one gallon of seed and then puddled into the soil before sowing. The type of rock phosphate used was "Hyperphosphate" from North Africa. This was prepared from a soft rock and was said to have a high citric solubility. It was particularly finely ground, 90 per cent passing through a 300 mesh sieve, and was considered to be the best type of insoluble phosphate for use in nurseries. In earlier field trials, however, it had shown no superiority over equivalent dressings of P_2O_5 derived from the somewhat coarser rock phosphate from Christmas Island.

The layout adopted was one of four or five randomized blocks of six plots each. The experiment started one year late in Negri Sembilan (Ulu Klawang).

Yields of grain are summarized in Table VII. It will be seen that in three trials, at Kota Bharu, in Kelantan, Bagan Serai, in Perak, and Dong, there were no overall significant differences demonstrated. At Telok Chengai and Ulu Klawang, all treatments were superior to control as were all treatments, except A (seed treatment), at Bukit Merah. At Pulau Gadong only the rock phosphate nursery treatment was superior to control, while at Talang and Briah the seed treatment (A) proved to be superior to C, D, E, and F and B, D and F respectively.

It is notable that in all six trials where positive responses were revealed one or other of the three seed or nursery treatments led to marked responses in yield. At Telok Chengai and Ulu Klawang the mean response in yield from these three treatments was 426 lb. per acre; this is remarkable when the low cost of the treatments is considered. Clearly, the simplest and cheapest of these three treatments was B from 1953-54 onwards, when mono-ammonium phosphate was applied to the nursery beds. This fact was considered when designing subsequent nursery manurial trials.

The series as a whole was associated with extensive lodging and considerable pest damage. There was some indication that vegetative growth was softest and lodging most severe in association with Treatments D and E. In the first season this could be explained on the assumption that the late-applied phosphate did not balance the heavy top dressing of nitrogen. It is also possible, in that season, that there was a reaction between the basic slag and sulphate of ammonia, which would cause a sudden release of ammonia in the irrigation water.

At several stations it was noted that early growth in the nurseries was particularly good in Treatments A and B. This suggests that water soluble fertilisers give the quickest results with young padi plants. The practical lesson suggested by this series is that the most efficient and economic method of applying phosphate to the padi crop is to give a small quantity of an expensive soluble phosphate to the nursery, followed up by water insoluble phosphate in the field.

Conclusions.

(1) Seed treatment with 1 lb. of potassium tri-basic phosphate *or* ½ lb. of mono-ammonium phosphate per gallon of seed led to a consistent yield response in four stations out of nine.
(2) A similar application to the nursery was of benefit at three stations out of nine.
(3) A nursery application of rock phosphate at 8 lb. per gallon of seed was of benefit at four stations out of nine.
(4) Field applications of double superphosphate or basic slag were of benefit at three stations and there was no difference between the two types of phosphate. Responses were particularly high at Ulu Klawang, being in the region of 1,211 lb. per acre.
(5) No responses to phosphate were demonstrated at Kota Bharu, Bagan Serai and Dong. At Kota Bharu there was severe lodging in D and E plots in the first two seasons, while at Dong pest damage was severe in 1951-52.

NURSERY MANURIAL SERIES.

This series was suggested by the very promising first year results obtained from the Russell Phosphate Series. The objects were:

(a) to investigate the effects on growth and yield of manuring nurseries with inorganic and organic fertilisers; and
(b) to study the effect of using double-sized nurseries in the presence and absence of nursery fertiliser.

The layout was a 2^3 factorial one with four replications arranged in eight blocks. Treatments were as follows:-

M — Nurseries manured with 2 lb. mono-ammonium phosphate per gallon (5.6 lb.) of seed;
O — Nurseries manured with 100 lb. well rotted cattle or buffalo manure for each gallon of seed;
S — Double-sized nurseries used—i.e. 60 sq. yd. per gallon of seed for a wet nursery or 6 sq. yd. for a *rakit* (floating) nursery (standard size being about 30 and 3 sq. yd. per gallon of seed respectively).

In the case of the floating nursery, all the organic manure and half the phosphate were incorporated in the raft before sowing, while the balance of the phosphate was used as a top dressing after the nurseries were broken up for the first transplanting.

Table VII.

Russell Phosphate Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Year	K_2PO_4 in Seed	K_2PO_4 in Nursery	Rock phosphate in Nursery	Superphosphate in Field	Basic Slag in Field	No P_2O_5	Basal Dressing K_2O (lb./acre)	Top Dressing N (lb./acre)	Standard Error	M.S.D. 5%	Remarks
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.													
K/P. 44	Telok Chengai	'51	4453	4276	4426	4163	4177	4097	—	100			
		52	3634	3741	3739	3449	3383	3226	15	50			
		53	4104	4188	4135	4223	4305	3910	15	50			
			4064	4068	4100	3945	3955	3745			± 63.203	190	
BM.18/51	Bukit Merah	51	1231	1514	1456	1366	1422	1351	—	100			
		52	1896	1933	1973	2034	2043	1890	15	100			
		53	1893	1890	1952	2084	2040	1883	15	100			
			1673	1779	1794	1828	1835	1708			± 15.233	46	
N.E. COAST REGION.													
Kn. 76	Kota Bharu	51	3135	3226	3237	2984	3179	3026	—	100			
		52	2227	2300	2285	1976	1838	2287	15	100			
		53	3206	3112	2904	3237	2904	3199	15	100			
			2856	2879	2809	2732	2641	2837			± 89.342	263	
MALACCA REGION.													
M. 32	Pulau Gadong	51	1470	1420	1690	1440	1360	1510	—	100			
		52	1690	1660	1830	1440	1650	1300	15	100			
		53	1800	1770	1990	1700	1800	1730	15	100			
			1653	1602	1820	1513	1589	1513			± 53.203	160	
CENTRAL REGION.													
Pk.C.8/51	Talang	51	2033	1203	1296	1163	1261	1603	—	100			Nitrogen top dressing applied 4 weeks after planting.
		52	2851	2753	2354	2281	2422	2432	—	100			
		53	2882	2928	2585	2408	1992	1968	—	100			
			2589	2295	2078	1951	1892	2001			± 147.55	445	
Pk.N.5/51	Briah	51	935	952	915	838	905	825	—	100			
		52	559	372	462	462	453	466	15	100			
		53	560	400	432	432	460	490	15	100			
			685	575	603	577	606	594			±27.1785	82	
Pk.N.7/51	Bagan Serai	51	1898	1850	1838	1250	1525	1808	—	100			
		52	1464	1551	1520	1298	1661	1519	15	100			
		53	2096	2281	2202	2266	2111	2244	15	100			
			1819	1894	1853	1605	1766	1857			± 63.173	190	
NS. 31	Ulu Klawang	52	2090	2218	1992	2809	2723	1846	—	100			
		53	3371	3628	3290	4007	4105	2514	15	100			
		54	3125	3354	3350	3989	4123	2884	15	100			
			2862	3066	2877	3602	3650	2415			±121.428	366	
W.Phg. (R) 13=23	Dong	51	790	1165	974	851	802	864	—	100			
		52	4204	4129	4339	4356	4230	4312	15	100			Adjusted for bird damage.
			2497	2647	2656	2603	2516	2588			±129.332	390	

Table VIII.

Nursery Manurial Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Season	Effects M	S	O	MS	MO	SO	M, O	Mean	Remarks
KEDAH, PERLIS, PROVINCE WELLESLEY REGION.											
K/P. 59	Telok Chengai	52-53	114	36	36	53	— 32	66	65	3648	
K/P. 59	Sala Kanan	52-53	195	217	— 122	— 32	125	— 160	28	3146	
		53-54	98	— 31	71	— 56	— 106	35	— 127	3683	Top dressed with S/A at 30 lb. N/acre.
			146	93	— 26	— 44	9	— 98	— 50	3414	
K/P. 59	Rantau Panjang	52-53	43	41	— 17	11	143	117	22	2102	
		53-54	190	— 68	23	95	29	86	7	2162	Top dressed with S/A at 30 lb. N/acre.
			117	— 13	6	44	87	69	51	2132	
K/P. 59	Kepala Batas	52-53	— 27	— 115	176	55	33	45	148	2090	
		53-54	54	— 84	— 151	— 55	46	12	57	1584	Top dressed with S/A at 30 lb. N/acre.
			13	— 99	12	0	40	29	— 45	1837	
Pg. 3/52	Sungei Acheh	52-53	237	93	— 42	612	195	54	264	1398	
		53-54	1321	— 5	1214	— 7	230	98	51	2080	
			779	44	586	302	— 18	76	158	1739	
Pg. 3/52	Bukit Merah	52-53	115	81	140	14	— 118	171	82	1587	
		53-54	85	34	62	— 3	20	52	49	1571	
			100	57	101	6	— 49	112	66	1579	
N.E. COAST REGION.											
Kn. 95	Bachok	52-53	424	121	45	45	173	108	16	1276	
		53-54	346	— 133	87	168	322	79	214	1687	
			385	— 6	66	106	248	14	170	1482	
MALACCA REGION.											
M. 54	Pulau Gadong	52-53	360	231	— 84	— 52	79	121	— 38	2738	
		53-54	224	210	— 25	— 53	22	— 10	— 43	3289	
			292	220	— 55	— 52	50	— 65	10	3013	
M. 59	Alor Gajah	52-53	108	— 192	22	60	— 37	67	— 453	2256	
CENTRAL REGION.											
Pk. N.1/52	Titi Serong	52-53	13	104	113	— 113	64	— 86	16	1845	
		53-54	— 116	79	11	— 55	115	60	125	2181	
			— 52	91	62	— 84	89	73	— 85	2011	
Pk. N.2/52	Simpang Tiga	52-53	215	106	102	206	160	95	18	2191	
		53-54	152	— 16	— 45	— 24	2	13	22	2443	
			183	45	29	91	83	— 113	— 5	2317	
Pk. C.3/52	Talang	52-53	— 51	— 6	73	108	— 2	128	270	1713	
		53-54	— 319	296	— 94	90	50	10	115	2946	
			— 185	151	— 10	99	24	84	62	2329	
N.S. 37	Kendong	52-53	— 41	— 24	62	[illegible]	9	54	— 36	3972	
		53-54	— 31	— 22	14	108	[illegible]	114	15	2573	
		54-55	— 32	42	113	104	61	77	17	3056	
			— 34	— 1	63	— 78	— 8	30	— 21	2853	
J. 107	Endau	53-54	64	31	— 46	— 4	111	85	22	1227	
Phg. 1/53	Kerdau	53-54	— 80	— 126	84	33	— 114	77	19	1604	
		54-55	241	169	161	57	— 22	101	75	1332	
			80	21	122	45	— 68	12	68	1468	
Sel. 91 B	Panchang Bedena	52-53	1	— 73	79	10	85	97	11	706	
		53-54	— 167	— 30	101	— 62	— 134	215	41	1078	
			— 82	— 52	90	— 25	— 23	121	26	892	

The Sungei Acheh (Province Wellesley) trial was incompletely planted up in the first season so a consolidated analysis was not possible. At Alor Gajah, the second season's results had to be discarded because of an error in layout.

Treatment effects are summarised in Table VIII. There were no overall significant effects demonstrated at five out of 16 stations, namely, at Panchang Bedena, in Selangor, Titi Serong, in Perak, Kepala Batas, in Kedah, Kendong, in Negri Sembilan, and Endau, Johore.

The following effects were highly significant (at 0.1 per cent) :-

Sg. Acheh	— M and O (1953-54 only)
Bachok, Kelantan	— M
Pulau Gadong	— M.

Effects significant at the 1 per cent point were:-

S. Acheh	— M.S. interaction (1952-53)
Pulau Gadong	— S
Alor Gajah, Malacca	— MSO interaction (1952-53)
Kerdau, Pahang	— O

Less significant results can be summarized as follows:-

M	—	7 times (negative at Talang)
S	—	twice (negative at Alor Gajah)
O	—	once
SO	—	once

years x S — once at Talang.

In a large series of factorial trials of this nature one would expect at least five effects significant at the 5 per cent point to have arisen by chance. Hence it is wise to ignore all these except where, by their consistency, they support results of greater significance.

The series as a whole has revealed a real benefit, in most cases, from manuring nurseries with ammonium phosphate. Organic manure has also been of benefit at Sg. Acheh and Kerdau but it would be unreasonable to expect a consistent effect from such a variable substance. This treatment was included in case it augmented the beneficial effect of the inorganic fertiliser, but in no case was the MO interaction significant.

Double-sized nurseries were of benefit at Pulau Gadong and perhaps at Talang. They also enhanced the beneficial effect of M at Sg. Acheh—a result easily understood where floating nurseries grow vigorously.

The isolated but very significant negative MSO interaction can perhaps be ignored as it is applicable to only one season's results. It is in any case difficult to interpret.

Conclusions.

(1) Manuring the nurseries with mono-ammonium phosphate has resulted in an increased yield of grain in nine experiments out of 16.

(2) Manuring the nurseries with organic manure occasionally benefits yield.

(3) Double-sized nurseries are beneficial at Pulau Gadong and also, in the presence of inorganic fertiliser, at Sg. Acheh.

(4) For practical purposes the commercial fertiliser Ammophos 11 : 48 can clearly be used instead of the much more expensive mono-ammonium phosphate (12 : 61 = N : P_2O_5 per cent).

Nursery Manurial Extension.

In the 1955 off-season, in the neighbourhood of Bukit Merah Padi Experiment Station, ten two-plot extension trials were laid down to demonstrate the value of nursery manuring with 2 lb. Ammophos 11 : 48 per gallon of seed. This fertiliser consists mostly of mono-ammonium phosphate with a small quantity of sulphate of ammonia.

Nurseries in this trial were centralised using the *japonica* variety Pe Bi Fun. Ten selected smallholders were given sufficient seedlings to plant up one 33 x 33 ft. plot each of manured and unmanured seedlings.

Mean yields of grain at harvest were as follows:—

Manured	1,168 lb. per acre	S.E. = 28.712
Unmanured	946 „ „ „	

The response in yield of 222 lb. per acre was highly significant and an excellent return for an outlay on fertiliser of about $2 per acre. Yields were low because of lack of irrigation in most plots. An irrigated check plot on the Experiment Station gave a response of 300 lb. per acre and a mean yield of 1,450 lb. per acre.

It may be concluded that wherever phosphate normally gives a response in yield this nutrient can be applied very effectively and economically to the padi nurseries in the form of Ammophos 11 : 48. Similar fertilisers with a higher N : P_2O_5 ratio would almost certainly be less desirable since sulphate of ammonia often inhibits germination.

Time of Application Series.

Field observations in the N.E. Coast Region had suggested a need for some nitrogen before planting since phosphate manuring had often resulted in marked yellowing of the crop some four to six weeks after transplanting. This series of experiments was designed to determine the optimum time of application for nitrogen and phosphate in this region.

The fertiliser mixture used consisted of sulphate of ammonia, double superphosphate and muriate of potash and supplied 50 : 40 : 30 lb. per acre of N : P_2O_5 : K_2O. The fertiliser was either cultivated into the soil before transplanting or else placed in the soil by hand some six to eight weeks later. Treatments were as follows:—

APPLICATION OF NUTRIENTS IN LB. PER ACRE

	Before Planting			6 to 8 Weeks Later	
	N	P_2O_5	K_2O	N	P_2O_5
A	50	40	30	—	—
B	25	40	30	25	—
C	—	40	30	50	—
D	—	30	30	50	10
E	—	20	30	50	20

At Pasir Mas and Bachok (both in Kelantan) the layout was one of eight and six randomized blocks respectively, whereas it was a 5 x 5 latin square at Gerai and Gelugor in Trengganu. The manured plot size was 22 x 22 ft. (22 x 33 ft. at Bachok) and the recorded plot size was 20 x 20 ft. (20 x 30 ft. at Bachok).

Harvest results are summarized in Table IX. At Pasir Mas, Treatments D and E were clearly superior to A, so the nitrogen is best applied only as a top dressing at this station. The reverse trend was noted on the sandy infertile soil of Bachok where Treatment A (all fertilisers applied before planting) was superior to B, E and D. At Gerai, B and C gave the best yields and were significantly superior to A.

At Gelugor, a new station, the trial commenced only in 1954 and the first year's results showed that E was superior to B and C. If this result is confirmed later, it would suggest that phosphate fixation is rapid in this soil.

It is important to note that at all stations the years x treatments interaction was significant. In other words, no one time of application will always be the best and the optimum time will doubtless depend on several factors of which the most important are water supply, amount of nitrogen in the irrigation water, initial fertility of the soil and the speed of phosphate fixation.

Conclusions.

(1) Over a three year period a late application of nitrogen gave the best results at Pasir Mas and an early application was best at Bachok. At Gerai, a split or a late application was best.
(2) Optimum time of application of nitrogen varies from season to season.
(3) If one year's results from Gelugor be excluded, then in no case was there any benefit from applying some of the phosphate later.

VARIETIES AND FERTILISERS SERIES.

The first series of trials was laid down in 1951 with the object of determining the optimum time or times of application of fertilisers to three different varieties suited to each locality.

The treatments are shown in Table X.

Table IX.

Time of Application of N and P Series.
Yields of Grain.
(lb. per acre)

Expt. No.	Place	Season		A	B	C	D	E	Mean	Remarks
			N before planting	all	half	—	—	—		
			N after „	—	half	all	all	all		
			P_2O_5 before planting	all	all	all	¾	half		
			P_2O_5 after „	—	—	—	¼	half		
N.E. COAST REGION.										
Kn. 93	Pasir Mas	'52-53		2992	3126	3249	3304	3160	3166	
		53-54		1741	1502	1454	1376	1475	1510	
		54-55		2222	2434	2537	2681	2719	2519	
				2318	2354	2413	2454	2451	2398	
Kn. 94	Bachok	52-53		2235	1975	1969	1671	1639	1898	
		53-54		1983	1603	1949	2086	1870	1898	
		54-55		2450	1611	2005	1770	1965	1960	
				2223	1730	1974	1842	1825	1919	
Tr. 22	Gerai	52-53		615	953	1119	765	975	885	1952-53 and '53-'54 season's yields are poor due to weather, *Leptocorisa acuta* and bird damage.
		53-54		289	441	501	412	445	418	
		54-55		3591	3954	3474	3607	3403	3606	
				1498	1783	1698	1595	1608	1636	
Tr. 33	Gelugor	54-55		3249	3007	3010	3064	3377	3141	

Table X.

Varieties and Fertilisers Series.

Treatments.

Locality	T. Chengai	Gerai	Pasir Mas	Pasir Puteh	Dong	Talang
Expt. No.	KP.45	Tr.19	Kn.81	Kn.86	Phg.26	Pk.C.9/51
Region	Kedah Perlis	N.E. Coast	N.E. Coast	N.E. Coast	Central	Central
V_1	R.C.4	R.C.4	R.C.4	R.C.4	R.C.17	M. Sepilai
V_2	M.E.80	M.E.88	A.I.Gresing	R.S.34	*	C.M.G. Bulat
V_3	Sm.29	Sm.29	Sm.29	Sm.29	Sm.29	Nachin 11

* Seri Menjadi in 1951 and M.E. 80 in 1952.

The fertiliser used was a mixture comprising 224 parts of sulphate of ammonia, 101 parts of 40 per cent superphosphate and 84 parts of muriate of potash. The application of nutrients was approximately as follows:—

N	—	47 lb. per acre.
P_2O_5	—	40 „ „ „
K_2O	—	50 „ „ „

The times of application of fertilisers were as follows:—

Sub-treatments	1	2	3	4	5	6	7	8
Before planting	All	—	—	half	half	—	1/3	nil
About 4 weeks after planting	—	All	—	half	—	half	1/3	nil
About 8 weeks after planting	—	—	All	—	half	half	1/3	nil

For the first dressing of fertilisers the usual method of application was to run off the water and then tread or cultivate the mixture into the soil. Later applications were plunged into the soil by hand or trodden below the mud surface.

The trial lasted for three seasons at Telok Chengai and Talang and for two seasons elsewhere. The layout consisted of six randomized blocks (four at Pasir Puteh) of three plots each; each plot was split into eight sub-plots for the manurial sub-treatments.

Comparison between yields from the different times of application gave very little information of value as trends differed from year to year. For this reason the results have been summarized on the basis of manure versus no manure (i.e. 1 to 7 v. 8) for each variety.

Yields of grain are summarized in Table XI.

It will be seen that there was a marked response to fertiliser application at all stations except Dong, which suffered from severe lodging

Table XI.

Varieties and Fertilisers.

Region	Place	Seasons	Grain Yield in Lb. per Acre					Effects in Lb. per Acre Manure—No Manure		Remarks
			Varieties	Manure	No Manure	Mean	S.E.			
Kedah/Perlis	Telok Chengai	1951-52	V1 R.C. 4	4084	3745	4041	± 33.716	339	± 92.0903	M — 0 sig. 0.1% Effect did not differ between varieties.
		1952-53	V2 M.E. 80	4147	3633	4082		514		
		1953-54	V3 Sm. 29	3561	3132	3507		429		
			Mean	3931	3503	3877		428	± 53.1684	
N.E. Coast	Gerai	1951-52	V1 R.C. 4	883	847	879	± 28.7386	36	± 66.8457	M — 0 sig. 0.1% Varieties differed highly significantly as R.C.4 showed no response to fertilisers.
		1952-53	V2 M.E. 88	1638	1060	1566		577		
			V3 Sm. 29	1374	903	1315		471		
			Mean	1298	937	1253		361	± 38.5934	
N.E. Coast	Pasir Mas	1951-52	V1 R.C. 4	1320	1059	1287	± 67.7306	261	± 80.5413	M — 0 sig. 0.1% Effect did not differ between varieties.
		1952-53	V2 A.1. Gresing	1304	964	1261		341		
			V3 Sm. 29	960	739	932		220		
			Mean	1195	921	1160		274	± 46.5005	
N.E. Coast	Pasir Puteh	1951-52	V1 R.C. 4	2854	1672	2706	± 136.686	1182	± 196.256	M — 0 sig. 0.1% R.S.34 and Sm.29 differed significantly (5%) in their response to fertilisers.
		1952-53	V2 R.S. 34	2719	1949	2623		769		
			V3 Sm. 29	2889	1462	2711		1427		
			Mean	2821	1695	2680		1126	± 113.308	
Central	Dong	1951-52	V1 R.C. 17	3145	2974	3124	± 105.217	172	± 171.344	There was no response to manuring. M.E.80 was planted only in the second season; another variety* was used in 1951.
		1952-53	V2 M.E. 80	2613	2747	2629		—		
			V3 Sm. 29	2802	2766	2798		36		
			Mean	2853	2829	2850		25	± 98.9257	
Central	Talang	1951-52	V1 M. Sepilai	2568	2215	2524	± 90.2864	353	± 150.665	M — 0 sig. 0.1% Effect did not differ between varieties.
		1952-53	V2 C.M.G. Bulat	2883	2536	2839		347		
		1953-54	V3 Nachin 11	1734	1595	1716		139		
			Mean	2395	2115	2360		280	± 86.9863	

* Seri Menjadi

in the first season and bird damage in the second. Second season yields at Dong were adjusted for bird damage.

This series of experiments provided valuable information as to the best variety to plant at the different localities but only at two stations (Gerai and Pasir Puteh) did the effect of manuring on yield of grain differ between varieties.

At Gerai, both M.E.88 and Sm.29 showed satisfactory responses to fertiliser whereas R.C.4 showed virtually no response. The mechanism of this effect appeared to depend on the apparently harmful effect of manuring this variety before planting. The mean effect of early manuring of R.C.4 for the two seasons was -265 lb. per acre. This effect was more marked in the first season, when R.C.4 flowered earlier than the other two varieties; the weather at the time was unfavourable, with frequent water-shortage, and this variety had a particularly large percentage of empty grains. In the second season, damage from birds and *Leptocorisa* was noted as being worst in the varieties R.C.4 and M.E.88, whereas Sm.29 suffered much more from lodging. It should be noted that Gerai depends on rainfall for water.

At Pasir Puteh, north of Gerai but also dependent on rainfall for water, Sm.29 responded best to manuring, R.S.34 least, with R.C.4 intermediate. Since the manured yields did not differ greatly between varieties, it can perhaps be assumed that Radin Siak 34 is the best variety to plant when manuring is not practised. With all three varieties one or other of the split dressings usually gave the best response, but no clear picture emerged nor did R.C.4 show the striking antagonism to early manuring which was noted at Gerai, only about 12 miles away to the south-east.

In 1951 a similar experiment was laid down at Kota Bharu, in the N.E. Coast Region, using off-season *japonica* padi varieties and with eight manurial sub-treatments, the times of application being three and six weeks after planting instead of four and eight weeks.

Grain yields are summarized in Table XII.

Table XII.

Varieties and Fertilisers Series.
Grain Yields and Effects at Kota Bharu.
(lb. per acre)

Varieties	Grain Yields			Effects	
	Manure	No Manure	Mean S.E.	Manure — No Manure	
V_1 Taichu 65	1657	1188	1599 ±110.03	469 ±194.449	
V_2 Pe Bi Fun	1380	1026	1355	354	
V_3 Goh Chee Sai	1354	1134	1826	220	
Mean	1464	1116	1420	348	±112.265

It will be seen that there was a marked response to fertiliser but that the effect did not differ significantly between varieties. With regard to time of application, there was an indication that Pe Bi Fun was intolerant of a full dressing of fertiliser before planting and that the optimum time was three weeks afterwards. It would be a mistake to give too much weight to this observation as the interaction between varieties and fertiliser treatments was non-significant. Nevertheless, this problem is receiving further attention in current experiments.

In 1953 it was noted that manuring often caused severe lodging of wet padi in the Raub district of West Pahang and there was a suggestion that certain local varieties, although intrinsically not as high yielding as the selected ones, were more resistant to lodging. As a follow-up to this observation a new trial was laid down at Dong in 1954 and a series of four-plot blocks was put down in neighbouring padi fields.

The object of the Dong experiment was to determine the effect of manuring on the growth, yield and lodging of five Serendah Kuning selections in central Pahang. The fertiliser dressing comprised a basal dressing of 40 per cent superphosphate and muriate of potash with a top dressing of sulphate of ammonia. The application of nutrient amounted to 30:30:15 lb. per acre of $N:P_2O_5:K_2O$. This experiment is due to continue for three seasons, so it would be out of place to consider the first year's results in detail. These, in fact, were very disappointing, there being no lodging at all and no response to fertilisers. Grain yields are summarized in Table XIII.

Table XIII
Varieties and Fertilisers Series.
Grain Yields at Dong.
(lb. per acre)

Variety	Manured	Control	Mean
Ser.K.3	3179	2874	3027
Ser.K.11.	2406	2309	2357
Ser.K.23	2446	2534	2490
Ser.K.31	2616	2616	2616
Ser.K.41	2604	2913	2758
S.E.	± 178.8218		± 126.4461
Mean	2650	2649	2650
S.E.	± 67.5019		

A series of four-plot blocks was distributed over 25 smallholdings in the Raub and Lipis districts of central Pahang with the object of

comparing the effect of manuring on growth, yield and lodging of one Ser. K selection and a local variety, the latter varying with locality and chosen by the smallholder. Each plot was 30 x 30 ft. in size, there being no discards between plots.

Grains yields are summarized in Table XIV. It will be seen that the response to manuring was highly significant (0.1 per cent) and the Ser.K.3 yield was superior (5 per cent) to that of the local varieties. The varieties x manures interaction was non-significant. Conditions did not favour lodging, there being none recorded in 16 out of the 25 blocks. In the remaining nine blocks the lodging percentage was as follows:—

	Lodging per cent	
	No Manure	Manure
Ser.K.3	9	10
Local	24	28

Table XIV

Varieties and Fertilisers Series.
Grain Yields in Central Pahang.
(lb. per acre)

	Local	Ser. K. 3	Mean
Manured	2232	2349	2290
Control	1879	1924	1901
S.E.	± 40.3001		± 28.4965
Mean	2055	2136	2096
S.E.	± 28.4965		

Conclusions.

(1) It would appear to be the exception rather than the rule for varieties to differ appreciably in their response to fertilisers. Where differences have been noted they have been associated with poor conditions of growth.

(2) Observations have indicated that where soil and drainage conditions favour lodging, especially of manured padi, then varieties which exhibit different degrees of resistance to lodging may be expected to differ in their responses to fertiliser. This hypothetical trend is being studied in current experiments but the first season's results have been largely negatived by relative freedom from lodging.

THE NPK FACTORIAL SERIES.

None of the earlier series of experiments had given any information on the potash requirements of the padi crop in areas where a response

to nitrogen and phosphorus could normally be expected. Similarly, the optimum ratio of N and P_2O_5 was still uncertain, so it was decided to lay down several 3^3 factorial NPK manurial trials on stations where a low experimental error could be expected. The stations selected were Kota Bharu, N.E. Coast Region; Telok Chengai, Hutan Kampong and Salan Kanan, all in Kedah; and Ulu Klawang in Negri Sembilan, Central Region.

In all cases the fertilisers used were sulphate of ammonia, double superphosphate (40 per cent P_2O_5) and muriate of potash (60 per cent K_2O). In Kota Bharu the $N_1P_1K_1$ level of fertiliser supplied approximately 47 : 40 : 50 lb. per acre of N : P_2O_5 : K_2O but in all the other trials this level supplied 30 : 30 : 15 lb. per acre of these nutrients. The phosphate and potash were applied, in the usual way, just before transplanting, while the nitrogen was given as a top dressing six to eight weeks later.

Kota Bharu.

At Kota Bharu, the experiment was a cumulative one, repeated on the same site each season as it was intended to test the long-term effects. Unfortunately the experiment station is scheduled for building purposes and the trial was concluded after the third residual season, fertilisers being applied only in the first and second seasons.

At all other stations a fresh site is used each season and a fresh randomization adopted. So far as possible, sites are chosen which have not received phosphatic fertiliser in the previous three seasons.

Harvest yields of grain from Kota Bharu are summarized in Table XV. It will be seen that there was a highly significant linear response to nitrogen and that this was repeated in the third season as a residual effect. Potash increased tillering in the first season only but had no overall effect.

The lack of response to phosphorus was unexpected as the site had received no phosphatic manure since November, 1947, when a dressing of 4 *pikul* (533 lb.) per acre bat guano was given. However, grain yields in the first season indicated a small response to the p_1 application in the presence of nitrogen as the N' P'' interaction was significant at the 5 per cent point.

Conclusions.

(1) Nitrogen is obviously the nutrient which limits yield at Kota Bharu. Clearly, applications exceeding 94 lb. per acre would continue to give increased responses.

(2) Phosphate appears to be required in relatively small quantities and then only in the presence of nitrogen.

(3) There is no indication that large quantities of potash are required at Kota Bharu. If an insurance dressing is to be applied it should be appreciably less than 84 lb. per acre of K_2O.

Table XV.
NPK Factorial Series.
Kota Bharu (Kn. 77)—Yields of Grain.
(lb. per acre)

1951-52		Double Superphosphate			Muriate of Potash			Mean
Sulphate of Ammonia		(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 65.86
	(n_0)	2042	1880	1934	1941	1980	1934	1952
	(n_1)	2337	2476	2554	2268	2366	2734	2456
	(n_2)	2680	3165	2882	2916	2806	3004	2909
Double Superphosphate			± 114.06			± 114.06		
	(p_0)				2331	2310	2418	2353
	(p_1)				2340	2510	2672	2507
	(p_2)				2454	2332	2583	2456
						± 114.06		
Mean ± 65.86		2353	2507	2456	2375	2384	2558	2439
		(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 55.16
1952-53	(n_0)	2283	2056	2265	2222	2199	2184	2202
	(n_1)	2604	2686	2667	2636	2558	2764	2652
	(n_2)	2799	2954	2866	2952	2847	2820	2873
			± 95.54			± 95.54		
	(p_0)				2577	2500	2608	2562
	(p_1)				2570	2704	2422	2566
	(p_2)				2662	2398	2738	2600
						± 95.54		
Mean ± 55.16		2562	2566	2600	2603	2534	2590	2576
		(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 50.964
Overall	(n_0)	2162	1968	2099	2081	2090	2059	2076
2 seasons	(n_1)	2470	2582	2611	2452	2462	2750	2554
	(n_2)	2740	3059	2874	2934	2827	2912	2891
			± 88.2722			± 88.2722		
	(p_0)				2454	2405	2513	2458
	(p_1)				2455	2607	2547	2536
	(p_2)				2558	2366	2660	2528
						± 88.2722		
Mean ± 50.964		2458	2536	2528	2489	2459	2574	2507
		(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 69.0939
Residual	(n_0)	2494	1985	2154	2169	2269	2195	2211
'53-'54	(n_1)	2482	2523	2422	2483	2348	2596	2476
	(n_2)	2752	2879	2551	2739	2757	2685	2727
			± 119.6742			± 119.6742		
	(p_0)				2646	2409	2673	2576
	(p_1)				2490	2383	2513	2462
	(p_2)				2257	2581	2289	2376
						± 119.6742		
Mean ± 69.0939		2576	2462	2376	2464	2458	2492	2471

Effects	Linear	Curv.
	± 88.2722	
N	516***	– 13
P	–200NS	27
K	27	40
	± 97.71	± 169.24
NP	69	
NK	– 40	
PK	3	

Effects	Linear	Curv.
N	814***	–141
P	70	– 87
K	84	146
	± 72.074	± 124.8358
NP	99	
NK	0	
PK	21	

*** At the 0.1 per cent point.

Table XVI.
NPK Factorial Series.
Telok Chengai (Kp. 66).
Yields of Grain.
(lb. per acre)

1952-53	Double Superphosphate			Muriate of Potash			Mean
Sulphate of Ammonia	(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 3.213
(n_0)	4178	3613	3784	3796	4080	3698	3858
(n_1)	3596	4128	3916	3952	3870	3819	3880
(n_2)	3924	3868	4318	3906	4352	3852	4037
Double Superphosphate		± 5.566			± 5.556		
(p_0)				3700	4359	3639	3899
(p_1)				3940	3754	3914	3870
(p_2)				4013	4189	3815	4006
					± 5.556		
Mean ± 3.213	3899	3870	4006	3884	4101	3790	3925
1953-54	(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 4.6368
(n_0)	3687	3689	3707	3664	3718	3700	3694
(n_1)	3685	3873	3840	3713	3980	3705	3799
(n_2)	3853	3875	4013	3908	3909	3924	3914
		± 8.0312			± 8.0312		
(p_0)				3773	3736	3717	3742
(p_1)				3756	3965	3715	3812
(p_2)				3756	3906	3898	3853
					± 8.0312		
Mean ± 4.6368	3742	3812	3853	3762	3869	3776	3802
1954-55	(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 58.6659
(n_0)	4243	4248	4117	4166	4125	4318	4203
(n_1)	4387	4383	4331	4357	4406	4337	4367
(n_2)	4405	4342	4438	4350	4467	4367	4395
		± 101.6123			± 101.6123		
(p_0)				4299	4467	4268	4345
(p_1)				4324	4206	4444	4325
(p_2)				4250	4326	4309	4295
					± 101.6123		
Mean ± 58.6659	4345	4325	4295	4291	4333	4341	4322
Overall 3 Seasons	(p_0)	(p_1)	(p_2)	(k_0)	(k_1)	(k_2)	± 20.2754
(n_0)	4036	3850	3869	3875	3974	3905	3918
(n_1)	3889	4128	4029	4007	4085	3954	4015
(n_2)	4061	4028	4256	4055	4243	4047	4115
		± 35,1180			± 35.1180		
(p_0)				3924	4187	3875	3995
(p_1)				4007	3975	4024	4002
(p_2)				4006	4140	4007	4051
					± 35.1180		
Mean ± 20.2754	3995	4002	4051	3979	4101	3969	4016

Effects	Linear	Curv.
N	197***	2
P	56	42
K	– 10	–254***
	± 28.6737	± 49.6643
NP	181***	
NK	– 19	
PK	25	
	± 35.1180	

*** At the 0.1 per cent point.

TELOK CHENGAI.

Yields of grain from the Telok Chengai experiment are summarized in Table XVI. The overall results indicate a highly significant linear effect of nitrogen which was enhanced by the presence of phosphate. There was a large negative curvature effect of potash which indicated a small response from the K_1 dressing while the K_2 dressing was either harmful or, at best, had no effect.

The first season's results were quite remarkable as the error was exceptionally low and all differences demonstrated were highly significant. Both nitrogen and phosphorus showed significant positive linear and curvature effects, the linear effect being enhanced when both nutrients were present. The linear and curvature effects of potash were both negative and highly significant, which emphasises the harmful effect of the double dressing of K_2O.

Conclusions.

(1) It has been shown over a three-year period that nitrogen is the nutrient which exerts the greatest effect on yields of wet padi at Telok Chengai. It has also been shown that applications of phosphate are essential for full expression of the yield increasing effects of nitrogen.
(2) A small application of 15 lb. per acre of K_2O appears to be beneficial but a larger one is either wasted or may be harmful.
(3) The optimum ratio of an NPK fertiliser for use at Telok Chengai would be 60+:60:15 of $N:P_2O_5:K_2O$. It should be remembered, however, that this station has a long history of phosphatic manuring using triennial applications of bat guano.

Graphs I, II and III illustrate certain of the more important effects demonstrated in these two trials.

OTHER NPK FACTORIAL TRIALS.

The other factorial trials at Hutan Kampong, Salan Kanan and Ulu Klawang have yielded only one year's results and need not be considered at this stage.

PEAT SERIES.

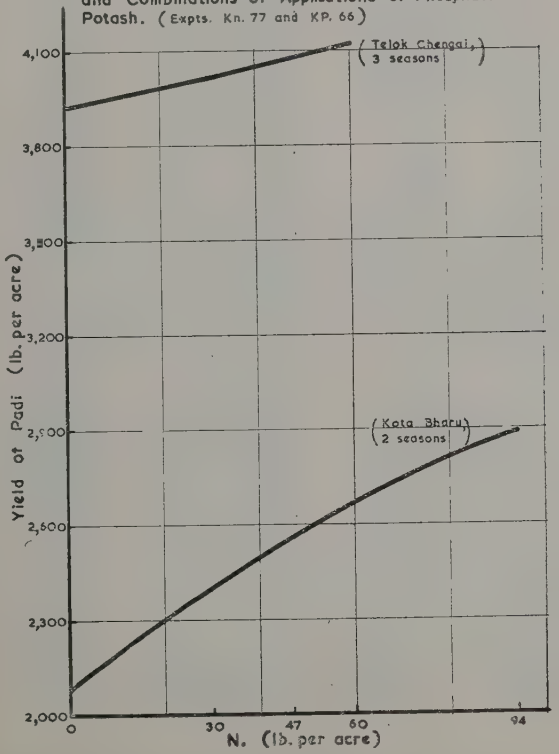
A number of manurial experiments are in progress on peat soils but they represent a peculiar environment for wet padi and their agronomic requirements have nothing in common with the alluvial padi soils of Malaya. It would be inappropriate, therefore, to review them in this paper.

Summary.

1. Ten series of wet padi manurial experiments are reviewed, covering 223 replicated experiments on Padi Experiment and Test Stations and 377 unreplicated trials on smallholdings.

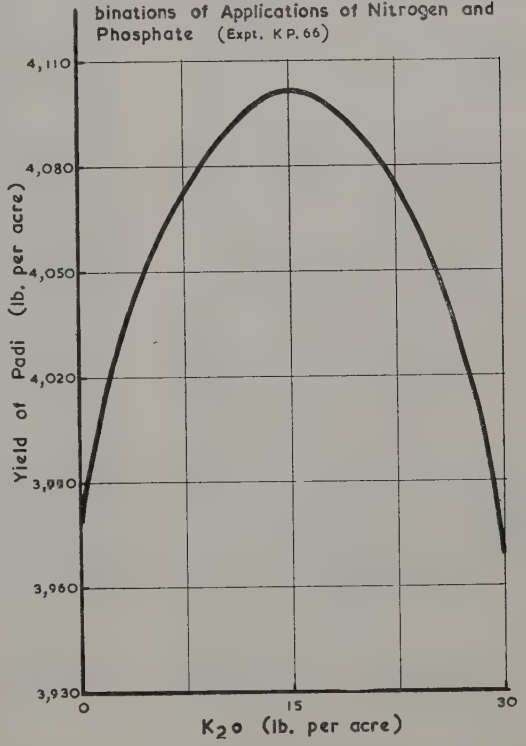
Graph I.

Average Responses to Nitrogen Over Several Seasons and Combinations of Applications of Phosphate and Potash. (Expts. Kn. 77 and KP. 66)



Graph II.

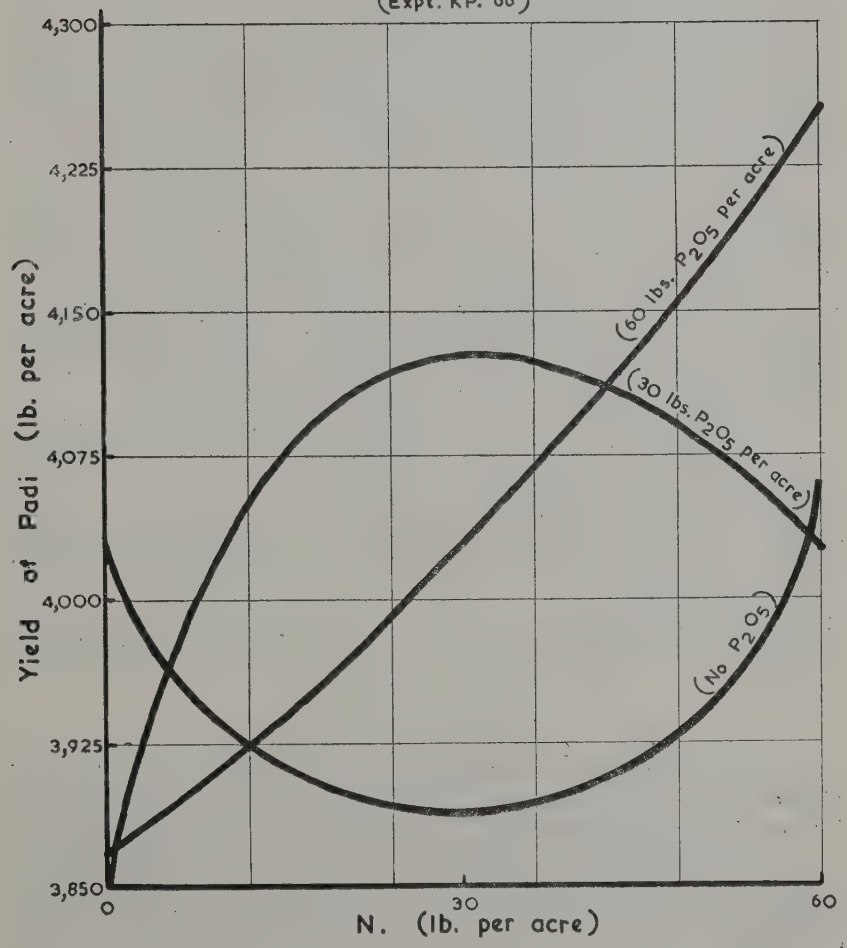
Average Response to Potash at Telok Chengai Over Three Seasons and Over Several Combinations of Applications of Nitrogen and Phosphate (Expt. KP. 66)



Graph III.

Average Responses to Nitrogen at Telok Chengai Over Three Seasons and Over a Range of Levels of Potash Application.

(Expt. KP. 66)



2. Ammonium nitrogen is shown to be preferable to the nitrate form, especially since it is cheaper. In so far as a nitrogenous top dressing is concerned, placement in the reducing zone is not important.
3. 'Ammophos' fertilisers are comparable in their effect with equivalent mixtures of sulphate of ammonia and double superphosphate.
4. Neither calcium nor magnesium appears to be required by wet padi in Malaya: magnesium may sometimes reduce yield.
5. The application of sulphates over a three-year period has been shown not to be harmful.
6. In the absence of NPK small quantities of calcium may sometimes increase yields but not in their presence.
7. Water soluble phosphate is by no means always superior to water insoluble forms such as fossil bat guano and rock phosphate. A dressing of 50 lb. per acre P_2O_5 as double superphosphate is usually equivalent to 100 lb. per acre in the water insoluble form. Only occasionally is the former superior.
8. Seed treatment or nursery manuring with readily available fertilisers will often result in responses in yield which are quite disproportionate to the cost of the fertiliser. This highly economic form of manuring can be recommended for widespread adoption.
9. In the N.E. Coast Region the optimum time of application of nitrogen varies with season and with locality. There seems to be no reason to change present practice whereby all phosphorus is applied before planting.
10. It is the exception for different padi varieties to differ appreciably in their response to fertilisers. Where differences occur they are associated with poor conditions of growth.
11. Both at Kota Bharu and at Telok Chengai, nitrogen has a greater effect in increasing yields than has phosphate. Phosphate is, however, essential for full expression of this effect at Telok Chengai and possibly so at Kota Bharu.
12. A small application of potash is beneficial at Telok Chengai but a larger one (30 lb. per acre K_2O) either has no effect or may be harmful.

Acknowledgements.

The very considerable tasks of checking and analysing the results of these trials have been carried out with great accuracy by Mr. I. Watson, Statistician, and Mr. Lee Yoke Heng, Assistant Statistician.

We thank all Field Officers and Assistants for the large amount of time and energy expended in the execution of these trials. The low experimental errors of many of the experiments bear witness to their efficiency.

Many colleagues, both past and present, amongst Research Branch officers have given invaluable advice on the design and conduct of this series of investigations. We also owe much to Dr. E. W. Russell for the lucid and practical advice contained in his 1950 report.

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REARING AND LIBERATION OF TACHINID PARASITES OF PADI STEM-BORERS IN MALAYA

BY

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Introductory.

The feasibility of utilising certain Tachinid flies which are parasites of sugar-cane borers in the West Indies for the parasitisation of local padi stem-borers was considered in 1938. Arrangements to liberate the Amazon fly (*Metagonistylum minense* Towns.) were made in 1939 and at least one consignment was dispatched from British Guiana. Owing, however, to the outbreak of war in Europe in the autumn of 1939 and the consequent delays in transit, all the parasites were already dead prior to their arrival in England *en route* to Malaya (2).

Post-War Arrangements.

The matter was taken up again in the middle of 1950 by the then Senior Entomologist (Mr. H. T. Pagden), and it was agreed, by Dr. F. J. Simmonds, the Director of the Commonwealth Bureau (now Institute) of Biological Control, that puparia of another parasite, viz. *Paratheresia claripalpis* van der Wulp., should be sent to Malaya from Trinidad. This insect is not unlike a bristly house-fly in appearance, and measures 7 mm. in length. The first consignment of the Trinidad strain of this fly (considered preferable to the Venezuelan one) was dispatched by air, 63 puparia arriving in Malaya in excellent condition early in April, 1951. This was the first of 20 such consignments, most of which took from nine to 11 days to reach the headquarters of the Department of Agriculture in Kuala Lumpur. The puparia arrived in celluloid vials containing damp moss and cotton wool.

It was expected from the start that some shipments might be lost altogether, but in fact only three batches were delayed, during June, taking 37, 43 and 45 days to arrive; surprisingly, two of these gave a 40 per cent emergence of flies.

By the end of July, padi harvesting was over in the Kuala Lumpur area and it was necessary to discontinue the dispatch of material from Trinidad owing to the scarcity of stem-borers. By then however, *Paratheresia* had been successfully reared on *Chilotraea polychrysa* (Meyr.) and on *Chilo suppressalis* (Walk.)

Six trial shipments of puparia of the Amazon fly *(Metagonistylum minense* Towns.) arrived, but one contained already emerged flies. Unfortunately, fertilised females of this species appeared less robust than *Paratheresia,* usually dying in five days. It behaved much more actively in the cages than did *Paratheresia.*

The plan for the following padi season was to liberate new stocks

of flies, bred in the laboratory, in an area specially chosen where long term (eight to nine months) padi was available, so as to increase the chances of carry-over of stem-borers between seasons. In the end, however, it was decided to liberate the flies in a double cropping area which was: (a) known to have serious stem-borer damage, (b) a fairly isolated area of about 40 acres and (c) easily accessible and safe for prolonged visits, i.e. did not require escorts on account of the Emergency.

After State and Settlement Agricultural Officers had been asked to suggest suitable localities, it was decided that a double cropping area was preferable to one with long-maturing padi plus wild grasses in the off-season. Such areas occur in Province Wellesley, and the Senior Entomologist (Mr. H. T. Pagden) chose a site near Padang Manora which satisfied all conditions. The first shipment of puparia arrived by air in mid-April, 1952; the final one, the 17th, arriving at the end of August. The course of this project from the receipt of the trial shipments in 1951 to the final liberation and attempted recovery is treated chronologically in the report which follows.

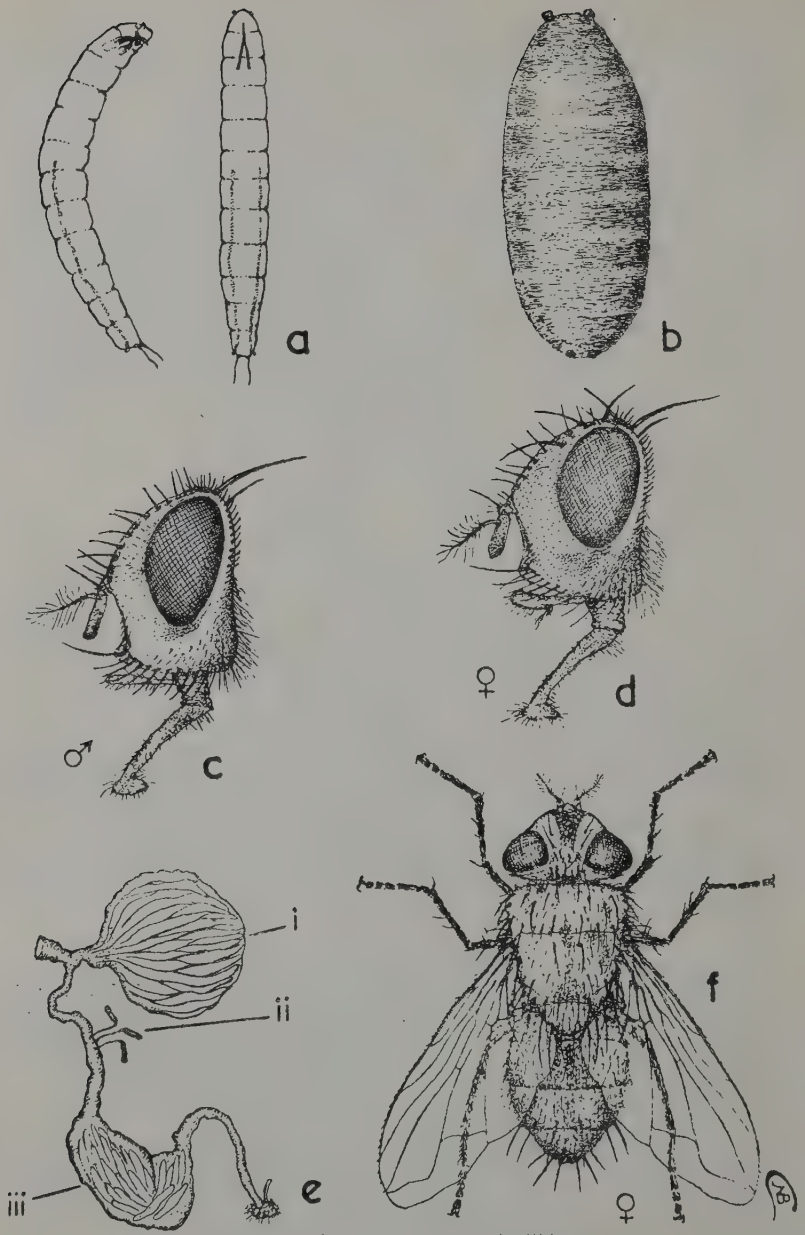
Reception of Material.

On arrival, the puparia were placed on wet moss in petri dishes within wooden emergence boxes (measuring 10 x 4 x 4 in.) with glass tubes let into each side of each box. The resulting flies were separated into males and females and placed in rearing cages measuring 14 x 10½ x 7½ in. These cages had two sides of "16" mesh wire gauze (later replaced with calico), one side made from the inner tube of a tyre and pierced with an access hole (normally blocked with a tin), and the remaining side of glass for easy observation. The tops of the cages were made of wire gauze and the bottoms of wood. Food was provided in the form of dilute honey water in a sponge with, in addition, split raisins, these latter being renewed daily. Finally, in each cage there was a petri dish containing wet cotton wool covered with filter paper, as it was stressed by Dr. Simmonds that well-aerated cages with plenty of moisture were the points to be aimed at in order to induce pairing.

Mating of the Flies.

Males are quickly recognised by the much paler abdomen with only a narrow median dark line, whereas there are dark patches on the first three abdominal segments of the female, More critical separation is effected by lateral examination of the head which, in the female, bears three pairs of prominent bristles (proclinate fronto-orbitals); these are absent in the male (Figs. c and d).

Males were kept from females for the first two days, as Bartlett (1) had shown that this encouraged pairing when they were later brought together. Males and females were put together in mating cages, similar in construction to the rearing cages, between 8 and 8.30 a.m. The cages were then placed on the laboratory verandah close to but not directly in a strongly sun-lit area, with the glass side of the



Paratherosia claripalpis van der Wulp.

(a) Larvae x 60
(b) Puparium x 8
(c) Head of male x 12
(d) Head of female x 12
(e) Reproductive system x 15
(f) Female fly x 8
(i) Ovary
(ii) Spermatheca
(iii) Uterus with larvae

cages away from the light. At intervals of 10 to 15 min. the cages were shaded with brown paper for about the same period. The cages had to be pushed forward at intervals in order to keep them close to the direct sunlight. They were taken back into the laboratory at about 11 a.m. During this time, copulation was most frequent during periods of restlessness lasting from 10 to 15 min.

Observation was continued till about 1 p.m., when the flies were again separated into the male and female cages, but there was, however, little copulation after 11 a.m.

The number of adults per cage was limited to a maximum of 30 but was often only between 10 and 20; the proportion of males to females was about 1:3, as it had been observed that copulation had been disturbed when too many males were present. Male flies over four days old seldom mated, as by then their wings were usually too badly damaged to allow of flight and they did not pair when able to progress only by hopping or crawling. The percentage of female flies mated was 16.5 of those which emerged.

During copulation, which occurred more often on the wire or cloth sides of the cage than on the floor, the pair was covered by a tube, measuring 3 x ¾ in., and then, by moving the tube slowly, the pair was induced to drop into it, making it possible for the female to be transferred to another cage. The removal of a mating pair was done about one minute after commencement of copulation to give allowance for the flies to adjust themselves; if removal was delayed longer, the pair would usually separate and the mated female could not then be recognised from others of her sex in the cage. The period *in coitu* varied from 3 to 14 min. and averaged about 10 min.; this period was longer than the average of 5 or 6 min., with one observation of 21 min., recorded by Jaynes (3). Acting on a suggestion from Dr. Simmonds, the mating cages were kept in a darkened room by day when not being used for mating.

Unfortunately, it was found that there was a very heavy mortality of flies four or five days after they had been fertilised; thus potential breeding material was lost after having been successfully mated. This handicap had similarly been experienced in Puerto Rico during breeding work between 1940 and 1943 (1).

Dissection of Flies and Inoculation of Stem-Borer Larvae.

Paratheresia, like many other Tachinids, does not lay eggs but deposits its larvae as minute, white maggots measuring about 1 mm. in length (Fig. a). In nature, it is believed that a fertilised female, having been guided to a stem containing a live caterpillar, places her abdomen at or near the opening of the burrow and expels one or more maggots which then enter and seek the borer within the burrow. As mentioned by Jaynes (3), these delicate larvae are able to penetrate any frass or droppings closing the entrance of the tunnel in the stem.

It had been found by experience in South America that instead

of waiting for normal larviposition, better results were obtained by lightly anaesthetising the female flies, dissecting the uterus in normal saline solution and squeezing from it the maggots, two of which are then placed by means of a fine brush onto the caterpillars. This is usually referred to as Scaramuzza's technique, but his paper (5) gives credit to H.K. Plank for the method. Stocks of caterpillars are collected in readiness so as to be available about 10 days after fertilisation of the flies. Originally 10 to 12 days was recommended as the period for keeping the fertilised females but this was later reduced to eight to 10 days.

Three-quarters to fully grown caterpillars of *Chilotraea polychrysa* (Meyr.)—then known as *Proceras polychrysus* (Meyr.)—the most serious stem-borer, were used first for inoculation, two fly maggots being placed on each borer. The developmental period as internal parasites varied from eight to 14 days, with an average of 10½ days, and the external pupal period was 14 days. Thus the total time taken for development averaged 24½ days. *Chilotraea* was chosen first for inoculation as, until 1949, it was regarded as being a *Diatraea*, which is the original host of *Paratheresia* in the West Indies and South America.

When attempts were made to transfer the maggots to the bodies of the caterpillars, it was found that although the finest paint brushes obtainable were used, the recently hatched maggots tended to crawl between the hairs and were very difficult to disentangle. Accordingly, the brushes were plucked so that about a dozen hairs were left, or very worn ones used. When the maggots were transferred to the caterpillars these latter adopted very violent lateral squirming movements in attempts to shake the maggots off. At first, the maggots were placed near the spiracles (breathing holes) in the belief that entry would thus be facilitated, but it was found that penetration was made at the intersegmental membrane, usually ventrally. By about the third day after inoculation it was usually possible to see the dark respiratory funnel at the posterior end of the parasitic larva. This chitinous organ is attached to a portion of a trachea close to a spiracle of the caterpillar, thus enabling the parasite to 'tap' the air supply of its host.

Ten to 15 minutes after inoculation, caterpillars were induced to enter cut portions of padi stems by stroking their hind ends with a fine brush. Fresh food was supplied every three or four days. When the Tachinid pupae appeared inside the dried larval skin they were kept till emergence of the flies, which were then separated by sexes as explained above. In only one case did two flies emerge from one caterpillar.

Caterpillars of *Chilo suppressalis* (Walk.) were next used as hosts and *Paratheresia* was similarly reared. The remaining Crambine, *Schoenobius incertulas* (Walk.), which has a somewhat worm-like larva, and the Noctuid *Sesamia inferens* (Walk.) had not been tested by the end of the 1951 padi season. However, in June, 1952, the writer inoculated 13 caterpillars of *Sesamia* with two maggots each and, although they penetrated the skin, moths emerged, thus showing that the maggots

had not developed within the caterpillars. It was noticed that *Sesamia* remained undisturbed when the maggots came into contact with the host, quite unlike the violent struggles of *Chilotraea* and *Chilo*. The average percentage of flies obtained from the larvae successfully inoculated was 33.8, which Dr. Simmonds considered a satisfactory figure. As a result of this laboratory work, it was arranged that 10,000 puparia of *Paratheresia* should be despatched from Trinidad, by air, in batches of 500 for the following padi season. The flies were to be released in one area which, as previously mentioned, had been chosen to provide the longest possible supply of padi and thus enable the parasites to find borers over as long a period as possible.

Liberation of *Paratheresia* in Province Wellesley.

Owing to the sugar cane season in the West Indies being at a different time from that of the padi season in Malaya, the best period for shipment of parasites from Trinidad (April to October) was the off-season here, the ideal time for Malayan requirements being between October and January. However, the double cropping locality chosen compensated for this, and the first consignment arrived in mid-April and was released in a small area, lying just north of Bukit Mertajam, between Goa Prau and Padang Manora, some 250 miles from Kuala Lumpur. A rather low average percentage of emergence (57.7) resulted from the first three consignments, the flies on these occasions being transported by rail and so suffering from the heat of the railway carriage. One consignment had been fumigated while inside its aircraft at Karachi; another had an unusually early emergence of flies and had to be taken to Province Wellesley by chartered aircraft.

The entomologist in charge of this project in Trinidad (Mr. F. D. Bennett) had recommended that the flies should be mated in the laboratory in Kuala Lumpur and held for a few days before release in the field. However, in view of the high mortality found to occur in mated females and also for the convenience of the staff and to reduce frequent travelling between points 250 miles apart, it was finally arranged by the then Senior Entomologist to send pupae by rail as soon as preliminary emergence of flies had started in Kuala Lumpur. This enabled the main emergence to occur at Bukit Mertajam, and liberations were made at two points in the chosen area between 6.30 and 7 a.m. or after 6.30 p.m. At these times, the flies were less active than during the heat of the day and the chances of pairing before dispersal were thus increased.

By this method, the percentage emergence from the fourth to the sixteenth consignments varied from 70 to 89.5, and from the total of 27 shipments received, 8,187 flies were released over six months, representing 94 per cent of emerged flies. This very satisfactory figure reflects credit on Mr. Goh Kee Guan, Agricultural Assistant, and Che' Abdul Majid bin Tahir Junior Agricultural Assistant, who made the liberations in the field at the two sites. These officers were also engaged on the breeding work in 1951.

It was most unfortunate that, owing to adverse weather, the padi, which would normally have been half grown in April and May, was either in the seedling stage or already due for harvest. However, there was an area of *menderong* (*Scirpus grossus* L.) as well as various grasses which, it was hoped, would serve as alternative host plants for the stem-borers during the off-season.

Attempted Recovery of *Paratheresia* in the Field.

Although the final release of parasites was not made till early in October, 1952, preliminary collection of padi stems was started at the two release points when harvesting began early in September, was repeated in November (3,700 bored tillers) and again in January and March, 1953 (3,125 bored tillers). However, no recovery of *Paratheresia* was made. An interesting point was that whereas in November 90 per cent of the stem-borers were *Chilotraea*, in four months this figure had dropped to only 10.5 per cent, *Schoenobius* comprising 58 per cent of all borers.

In addition to stem counts, collections were made of flies which had settled on padi leaves and those taken on the wing, but no specimens of *Paratheresia* were recovered. The two commonest Tachinids captured were *Sarcophaga dux scopariiformis* S. W. and *S. calicifera* Bottch. The latter, as well as *Sturmiopsis semiberbis* (Bezzi), was bred from larvae of *Chilotraea polychrysa* (Meyr.), showing that at least two local species of Tachinids occur naturally in this area as actual stem-borer parasites.

An interesting record from padi stems at Padang Manora was the presence of a Tabanid, or 'horse fly', feeding on caterpillars of *Chilotraea polychrysa* (Meyr.). This fly was identified by the Commonwealth Institute of Entomology as *Tabanus striatus* F.; it has since been taken in Selangor, feeding on the bodies of cattle. Two specimens of these Tabanid maggots were supplied with stem-borers (*Chilotraea*), one maggot consuming five larvae in three weeks and the other six in four weeks. Larvae of Tabanids are usually found feeding on earthworms, various Arthropoda and snails in damp soil, under stones or in rotten logs. This appears to be the first Malayan record of a larva of the family Tabanidae feeding on insects.

The most recent search for *Paratheresia* was in January, 1955, when the Entomologist (Mr. I. J. Wyatt) and Mr. Goh Kee Guan failed to find any Tachinids in the area, in fact all flies were very scarce. Spiders, however, were observed to be very abundant on the padi leaves at Padang Manora and may have exercised control of the introduced Tachinid, though as seen above, local species are present as parasites.

Summary.

The breeding of the tropical American fly *Paratheresia claripalpis* van der Wulp. from pupal material dispatched by air from Trinidad is described. The fly was successfully reared in 1951 on larvae of *Chilotraea polychrysa* (Meyr.) and *Chilo suppressalis* (Walk.). No success

was obtained with *Metagonistylum minense* Towns. similarly sent from the British West Indies.

The inoculation of stem-borer caterpillars with maggots dissected from the uteri of fertilised flies is described.

A total of 8,187 flies (representing 94 per cent of those that emerged) was released in 1952 in a double cropping area of padi in Province Wellesley. Attempts to recover the parasite in 1952, 1953 and 1955 have been unsuccessful.

Although it is naturally disappointing that *Paratheresia* has not yet been recovered in Malaya, this also happened following its introduction into Puerto Rico, Cuba and Antigua (5). With the proposed establishment in India of a research station to study parasites in South East Asia, further work along these lines is postponed for the time being.

Acknowledgements.

The writer is obliged to Dr. F. J. Simmonds, the Director, and Mr. F. D. Bennett, the Entomologist, of the Commonwealth Institute of Biological Control, Trinidad, B.W.I., who dispatched the consignments and gave valuable information on the handling required. Mr. Goh Kee Guan, Agricultural Assistant, and Che' Abdul Majid bin Tahir, Junior Agricultural Assistant, did excellent work in the breeding and liberation of the flies and kept very careful notes of all phases of the work.

Others who should be mentioned are the Medical Officer, Bukit Mertajam, for allowing the use of a portion of a hospital ward during some critical days of heavy fly emergence, and Mr. J. A. Aitken, M.C., the then District Officer, Bukit Mertajam, for kindly providing accommodation before there was a rest-house at Bukit Mertajam.

The sketches are by Mr. Ng Beng Cheng.

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DOUBLE CROPPING OF WET PADI IN PROVINCE WELLESLEY

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Introduction.

It has often been a criticism of padi cultivation in Malaya that only one crop is planted, and the Department of Agriculture has always been fully alive to the possibility of introducing double cropping. One factor that undoubtedly has discouraged such a practice is the long maturation period of certain Malayan varieties, particularly those grown in north Krian, Perak, where all the popular varieties have a maturation period of about 220 days (3). Clearly, double cropping with such varieties is out of the question.

A serious attempt to cultivate padi in the so-called off-season was made in 1936 and 1937 at Pendiat in the Bota Irrigation Area, Perak, where 20 acres was cultivated for two seasons with the following strains of padi:-

Radin 11 and 13
Siam 29
Radin Siak 34
Reyong 20
Nachin 756.

This attempt ended in failure associated with very severe attack by stem-borers and no clear conclusion was reached as to whether failure should be attributed to photosensitivity of the padi varieties tested or to seasonal influence on pest damage or to a combination of both factors (2).

This remained the position up to the invasion of Malaya by Japanese armies in 1941, at which time only *indica* varieties were cultivated locally.

The Introduction of Japonica Varieties.

During the occupation of Malaya, the Japanese introduced seven *japonica* varieties from Formosa and these are locally referred to as *Taiwan* padi (5). Of these varieties, four are still in cultivation and two new varieties have emerged, these being single plant selections from Pebifun (4). All these varieties normally mature in about 120 days from sowing.

At the end of the war considerable areas of padi of *japonica* varieties were in cultivation but there were no clear-cut distinctions

between seasons and such indiscriminate cultivation was associated with intensive pest damage, attacks by the Black Padi Bug, *Scotinophora coarctata*, being of particular severity. At the same time, Blast Disease, *Piricularia oryzae*, was found to be of widespread occurrence and its introduction was associated with the *japonica* varieties (5), but this belief is now largely discredited.

Cultivation of *japonica* varieties became sporadic in most States and Settlements but persisted in Province Wellesley Central in the neighbourhood of the Bukit Merah Padi Experiment Station.

Departmental Policy.

The policy based on observations in 1946 was unfavourable to double cropping on the following grounds:—

(a) danger of Blast Disease;

(b) that evidence suggested that the total yield from two crops in one year was less than that from one good main crop; and

(c) that off-season cultivation delayed the planting of the main crop and led to reduced yields.

The need for investigations was obvious and the Settlement Agricultural Officer, Penang, arranged for a series of test cuts to be taken in 1947 and early in 1948. The results of these sample cuts are summarized in Table I.

Table I.

Yields of Padi in the 1947 Off-Season and the 1947-48 Main Season.

Season	Type of Crop	Yields	
		(g.* per acre)	(kg. per ha.)
1947	*japonica*, double-cropped for several seasons	236	1,481
1947-48	*indica*, " " " " "	253	1,588
	Total of the two crops	489	3,069
1947	*japonica*, double-cropped for one season	182	1,142
1947-48	*indica*, " " " " "	279	1,751
	Total of the two crops	461	2,893
1947-48	*indica*, single-cropped areas (normal practice)	280	1,758

* g. = *gantang*. 1 *gantang* = 1 gallon = 5.6 lb. approximately.

It will be seen that, although yields were on the low side, there was no evidence to suggest that the *indica* crop suffered from double cropping or that the yield from one crop of *indica* approached the sum of two crops from a double-cropped area.

Investigations over a period of years were clearly required and these were, in fact, carried out and will be described in this paper.

Irrigation Problems.

The area under double cropping in Central Province Wellesley lies within the Sungei* Kulim Irrigation Area, which was designed for single cropping during the wettest period of the year. It could not be expected that full irrigation could also be supplied in the off-season for the following reasons:—

(i) a period without irrigation was required each year for off-season repairs to canals and other irrigation works. This was particularly necessary in 1947 because of the neglect of such repairs during the Japanese occupation of Malaya;

(ii) there was sometimes insufficient water in the Sg. Kulim to provide full irrigation during the comparatively dry off-season; and

(iii) off-takes and canals were designed to supply the average quantity of water required during the main season.

The first of these factors prevented the supply of off-season irrigation in 1947, 1948 and 1955. The third was partly eliminated by the Drainage and Irrigation Department when they increased the size of irrigation off-takes in 1948 in order to make full use of the available water. The second factor means that reliable off-season irrigation can never be supplied to the whole Irrigation Area but only to a portion of it.

The problem of off-season repairs to irrigation works can be solved either by growing *japonica* varieties in both seasons or by evolving special short-term *indica* varieties for the main season.† Experience has shown conclusively that the combination of a medium-term *indica* variety and an off-season *japonica* crop leads to seasons becoming progressively later with consequent confusion in the field.

Fortunately, the *japonica* varieties are not photo-sensitive in this country (4) but cultivators, until recently, were unwilling to grow

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* Sungei = river

†*Comment by the Drainage and Irrigation Department.*

In practice, however, the repairs problem would be difficult. What can be accomplished now in four months by the maintenance organisation with a certain measure of support from the farmers could not be accomplished with the same effort in two periods of two months. There would have to be a greater strength of executive officers and a far greater degree of support from the farmers. Alternatively it would be necessary to forego a second crop every second or third year, if it should turn out that adequate attention to repairs would not be practicable in two annual periods of two months each. In any case irrigation for a second crop would have to be denied when major repairs taking more than two months were undertaken.

It must also be understood that failure of any large section of the planters to plant two 4-month maturation crops can cause a complete breakdown of the irrigation programme.

these in both seasons as they complained that the rice was unpalatable. It now appears possible that palatability can be improved by adopting a different system of cooking, and double cropping with these varieties is now acceptable to an increasing number of cultivators. It is the policy, therefore, to encourage two *japonica* crops per year, where irrigation facilities permit, and at the same time to continue selection of short-term *indica* strains, including *indica* x *japonica* hybrids, in an endeavour to produce alternative short-term varieties.

Field Investigations.

Triple Cropping.

It was realized in 1947 that a possible objection to double cropping was that this practice would lead to declining yields because of soil impoverishment. If there were any truth in such an objection, it was argued that soil impoverishment would be aggravated by continuous or triple cropping, and this was commenced on an experimental basis in 1948 at Bukit Merah. One two-acre field was in fact cropped continuously for 18 crops, or six years, and a fertiliser experiment was superimposed on the last nine crops. The *japonica* variety Pebifun was used throughout as this is the standard padi used for off-season cropping.

The fertiliser dressing consisted of 532 lb. per acre of a mixture of sulphate of ammonia, single superphosphate and muriate of potash analysing 8.8:7.6:9.5 per cent $N:P_2O_5:K_2O$. This was applied according to the following treatment combinations:—

(a) all fertiliser applied at planting;
(b) „ „ „ 3 weeks after planting;
(c) „ „ „ 6 „ „ „ ;
(d) fertiliser applied half at planting and half 3 weeks later;
(e) „ „ „ „ „ „ „ 6 „ „
(f) „ „ „ „ 3 weeks and half 6 weeks after planting;
(g) „ „ one third at each time; and
(h) control—no fertiliser application.

Plot size was 33 x 33 ft. and the lay-out consisted of four randomized blocks.

Details of the 18 crops are summarized in Table II, while the Bukit Merah average rainfall is shown in Fig. I.

It will be noted that it was possible to obtain three crops within one year, but this was only with the aid of mechanical cultivation and smallholders could not be expected to achieve this efficiency. Nevertheless it emphasizes the fact that double cropping with short term padi varieties is clearly consistent with an adequate period for off-season repairs.

It is interesting to note that the highest mean yield was obtained from the 15th crop while the last crop was only 224 lb. per acre (251 kg. per ha.) less than this.

Table II.

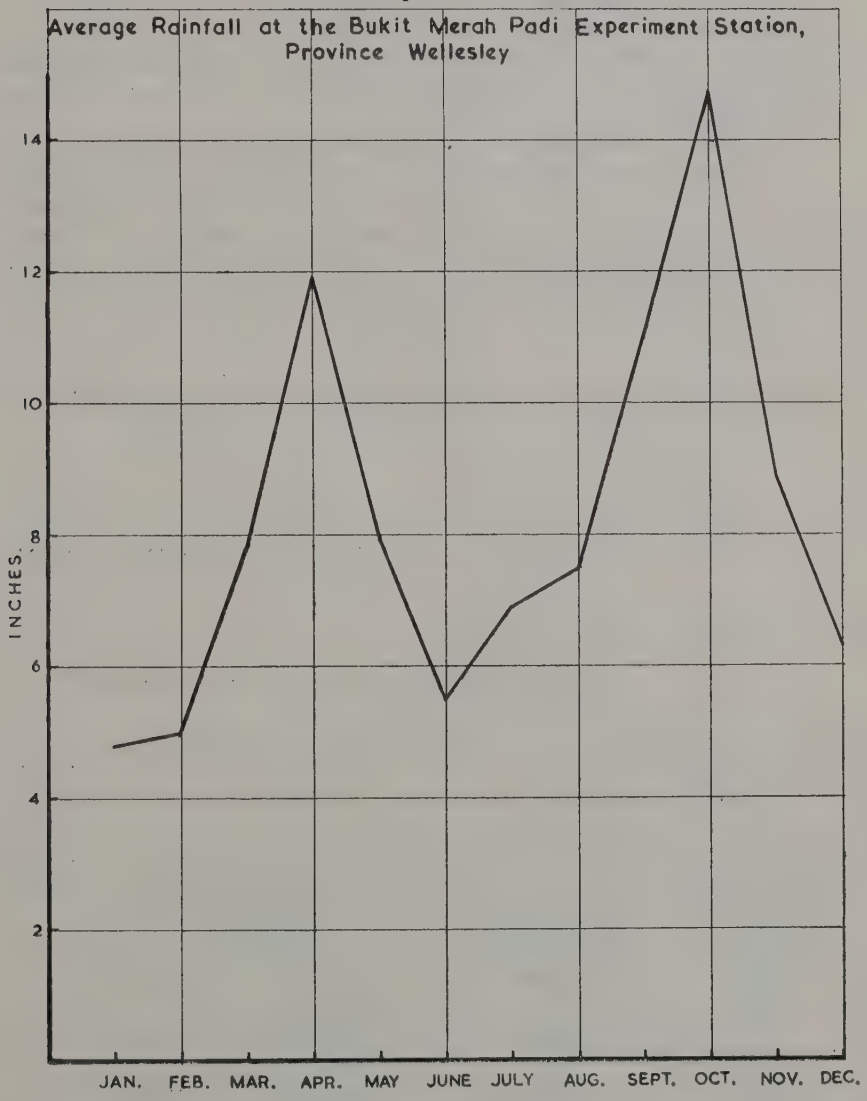
Triple Cropping at Bukit Merah Padi Experiment Station.

Crop	Date of Transplanting	Date of Harvest	Mean Yield of Grain (lb. per acre)	Effect of Fertiliser (lb. per acre)	Standard Error	Remarks
1	28.8.48	26.12.48	1,100	—	—	
2	18.1.49	18. 4.49	78	—	—	Severe rat and bird damage
3	9.5.49	18. 8.49	1,362	—	—	
4	9.9.49	24.12.49	407	—	—	
5	15.1.50	16. 4.50	732	—	—	Bird damage
6	10.5.50	19. 8.50	1,455	—	—	
7	11.9.50	—	—	—	—	Completely destroyed by birds
8	11.1.51	17. 4.51	506	—	—	
9	11.5.51	15. 8.51	1,399	—	—	
10	8.9.51	14.12.51	380	22	± 99.27	Considerable rat damage
11	8.1.52	15. 4.52	1,878	142*	± 52.35	
12	10.5.52	26. 8.52	1,365	284***	± 42.31	Wet harvest
13	11.9.52	15.12.52	459	-39	± 95.26	Considerable bird damage
14	10.1.53	15. 4.53	1,331	130	±122.22	Severe bird damage
15	11.5.53	15. 8.53	1,979	460***	± 73.36	
16	11.9.53	15.12.53	878	172	±156.41	Severe bird damage
17	13.1.54	20. 4.54	872	259***	± 41.88	
18	14.5.54	23. 8.54	1,755	416***	± 40.05	
Mean yield per crop (10—18th)			1,211	205***	± 32.38	
Mean annual yield (4—6th)			3,632			

* Significant effect at the 5 per cent level.

*** Significant effect at the 0.1 per cent level.

Fig. I.


Average Rainfall at the Bukit Merah Padi Experiment Station, Province Wellesley
INCHES.
14
12
10
8
6
4
2
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

Mean yields of manured and unmanured crops were as follows:—

Crops	Treatment	Mean Yield of Grain (lb. per acre)	(kg. per ha.)
1-6 and 8-9	unmanured	880	986
10 - 18	unmanured	1,031	1,156
10 - 18	manured	1,236	1,385

There was no decline in yield from the unmanured crops and manuring was able to increase yields by an average of 205 lb. per acre (229 kg. per ha.).

Detailed yields from each treatment are given in Table III.

It will be seen that although the optimum time of application of fertiliser varied from crop to crop, the best overall yields were obtained when all the fertiliser was applied six weeks after planting. This treatment was in fact significantly superior (at the 5 per cent level) to all other treatments except that where the dressing was split and half applied at three weeks and the balance six weeks after transplanting.

Double Cropping.

A double cropping experiment, with traditional manuring, was laid down in 1947 with the following treatment combinations:

Main Treatments (Off-Season).

1. Fallow
2. *japonica* padi
3. „ „ manured with 4 *pikuls** per acre bat guano.
4. „ „ „ „ 8 „ „ „ „ „

Sub-Treatments (Main Season).

(a) *indica* padi, unmanured
(b) „ „ , manured with 4 *pikul* per acre bat guano.
(c) „ „ , „ „ 8 „ „ „ „

The sample of bat guano used had an analysis of 12.49 per cent P_2O_5, so a dressing of 4 *pikuls* per acre was equivalent to 66.6 lb. per acre of P_2O_5 (746 kg. per ha.).

The layout consisted of a 4 x 4 latin square with plots 33 x 35 ft. surrounded by a 1 ft. *batas* (bund). Sub-plot size was 33 x 11 ft. All the bat guano was applied 11 days after transplanting; it was not applied to each crop but in accordance with the following schedule:—

Season	Off-Season	Season	Main Season
1947	Manured	1947-48	Manured
1948	—	1948-49	—
1949	Manured	1949-50	Manured
1950	—	1950-51	—
1951	Manured	1951-52	Manured
1952	—	1952-53	—
1953	Manured	1953-54	Manured
1954	—	1954-55	—

* 1 pikul = 133⅓ lb.

Table III.

Triple Cropping and Manuring Experiment, Bukit Merah.

Mean Yields of Grain, 1951 to 1954.

(lb. per acre)

Crop	Fertiliser at Planting	Fertiliser Applied 3 Weeks After	Fertiliser Applied 6 Weeks After	Half at Planting Half at 3 Weeks	Half at Planting Half at 6 Weeks	Half at 3 Weeks Half at 6 Weeks	One-Third at Each Time	Control, No Fertiliser	S.E.	M.S.D. at 5 per cent	Mean Yield
10	444	205	590	401	317	458	263	361	± 92.86	273	380
11	1,908	1,812	1,936	1,835	1,917	1,858	2,001	1,753	± 48.97	144	1,878
12	1,359	1,400	1,341	1,365	1,438	1,443	1,456	1,116	± 39.58	116	1,365
13	422	367	643	538	417	505	287	493	± 89.11	262	459
14	1,213	1,508	1,380	1,191	1,383	1,461	1,294	1,217	± 114.32	336	1,331
15	2,001	1,888	2,122	2,009	1,973	2,120	2,143	1,577	± 68.62	202	1,979
16	838	894	1,376	764	673	793	960	728	± 146.31	430	878
17	892	926	870	934	907	885	919	646	± 39.17	115	872
18	1,786	1,779	1,793	1,829	1,823	1,798	1,838	1,391	± 37.46	110	1,755
Mean	1,207	1,198	1,339	1,207	1,205	1,258	1,240	1,031	± 30.29	89	1,211

It was realized that this system of manuring was unbalanced and, with effect from the 1955 off-season, treatments were amended whereby fertilisers were applied to each crop, the four *pikuls* of bat guano per acre being replaced by 30:30:15 lb. per acre of $N:P_2O_5:K_2O$ with the PK dressing supplied before transplanting as bat guano and muriate of potash and the nitrogen given as a top-dressing five to seven weeks afterwards.

This is a classical experiment repeated year after year on the same site in order to yield cumulative results.

Yields for the period 1947 to 1955 are summarized in Table IV.

Table IV.

Double Cropping of Wet Padi.

Yields of Grain.

Season	Main Season Yield after Off-Season Cropping (lb./acre)	Main Season Yield after Off-Season Fallow (lb./acre)	Off-Season Yield (lb./acre)	Annual Yield of Double Cropped Area (lb./acre)
1947-48	2,076	1,979	863	2,939
1948-49	1,870	1,873	1,384	3,254
1949-50	1,217	1,309	1,190	2,407
1950-51	1,394	1,299	1,206	2,600
1951-52	1,871	2,017	168	2,039
1952-53	1,501	1,577	1,203	2,704
1953-54	1,622	1,755	1,482	3,104
1954-55	1,645	1,714	1,459	3,104
Mean	1,650	1,690	1,119	2,769
	(kg./ha.)	(kg./ha.)	(kg./ha.)	(kg./ha.)
1947-48	2,327	2,218	967	3,294
1948-49	2,096	2,099	1,551	3,647
1949-50	1,364	1,467	1,334	2,698
1950-51	1,563	1,456	1,352	2,914
1951-52	2,097	2,261	188	2,286
1952-53	1,682	1,768	1,348	3,031
1953-54	1,818	1,967	1,661	3,479
1954-55	1,844	1,921	1,635	3,479
Mean	1,849	1,894	1,254	3,103

The results are shown clearly in block diagrams in Fig. II.

It will be seen that the mean annual gain from double cropping amounts to 1,079 lb. per acre (1,209 kg. per ha.) and that, as yet, there is no marked falling off of the main season yield in the double-cropped area.

The detailed yields are shown in Table V. These are of considerable interest and a study of them reveals the effect of continuous double

cropping without manuring. The deleterious effect of this practice was first evident in the 1951-52 season, as shown by the comparison between mean yields of 1(a) and 2(a). The difference was again appreciable in 1953-54. However, this can be counteracted by manuring, as witnessed by the fact that in no season was the mean yield of Treatment 4 significantly less than that from Treatment 1.

The effect of manuring can be demonstrated clearly by comparing the yield from 4(c) with 2(a) from season to season. This effect was consistent, but not always statistically significant. Nevertheless it was a comparatively small effect when compared with the size of the bat guano application. This is ascribed to its lack of balance, which is the chief objection to traditional fertiliser practice. This view gains support from the sudden increase in fertiliser response noted in the 1955 off-season when the mean yield from the 4(c) treatment combination was 2,475 lb. of grain per acre (2,774 kg. per ha.) as compared with 1,023 lb. per acre (1,147 kg. per ha.) from 2(a). As might be expected, this indicates that the more intensive the cropping the more important is it to manure the padi field. It also emphasizes the importance of balanced NPK manuring on this soil, and the high yield from the manured crop gives promise of an annual yield of two tons of padi per acre.

Double Cropping in Province Wellesley Central.

It has already been noted that double cropping of wet padi has been practised since the Japanese occupation in Province Wellesley Central. The areas cultivated in this district and means yields are shown in Fig. III. It will be noted that, as the area increased, so did the yield. Doubtless pest damage was more severe in the smaller areas as this has been the experience in all States and Settlements whenever isolated small areas have been cultivated.

Double Cropping in Other Areas in Malaya.

Double cropping is practised to a limited extent in north Province Wellesley where irrigation problems are more difficult. It has also been practised for several years on a limited area in the Yen district of north Kedah where the perennial streams flowing north from Kedah Peak *(Gunong Jerai)* provide a limited irrigation supply. Here yields have always been consistently high, the mean yield from 355 acres in 1955 being 2,957 lb. per acre of grain (3,314 kg. per ha.).

Double cropping is being practised on an experimental scale in the Salor Irrigation Area, Kelantan, (1) but it is too early to say if this will prove to be successful. An area of 104 acres was planted in 1953 and a smaller one in 1954 and 1955. Here, one of the difficulties which limit extension is the lack of interest shown by the smallholders, but intensification of cropping in Kelantan also brings with it problems of feeding cattle which would normally be grazed on the fallow fields during the off-season.

Fig. II.

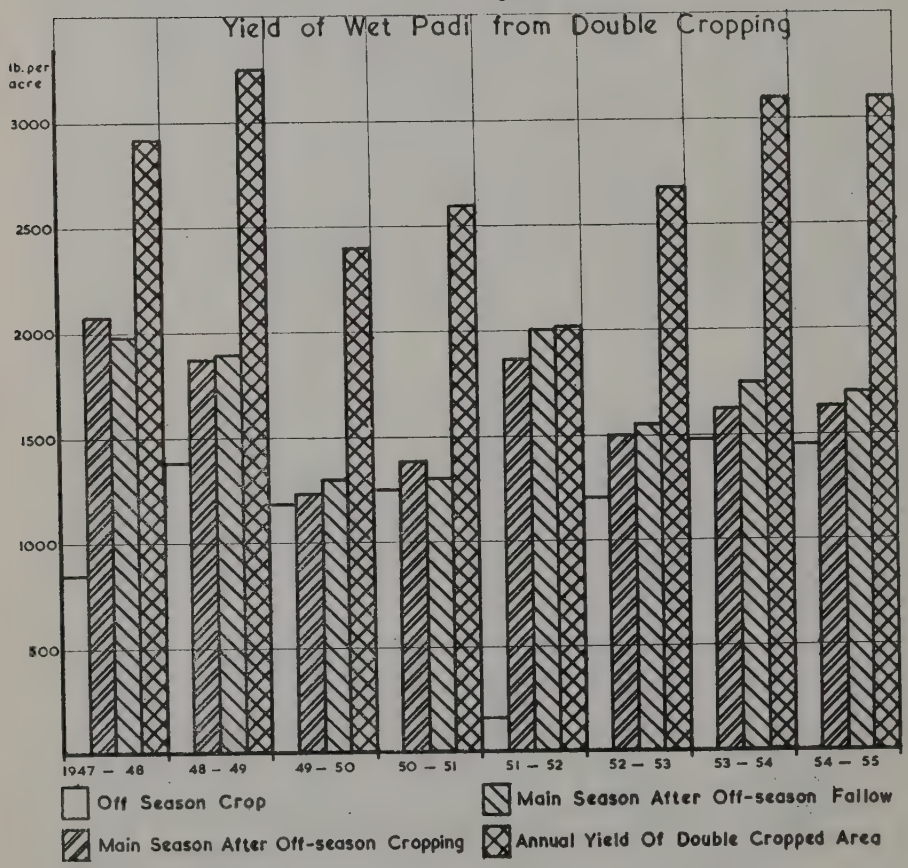

Yield of Wet Padi from Double Cropping
lb. per acre
3000
2500
2000
1500
1000
500
1947 – 48
48 – 49
49 – 50
50 – 51
51 – 52
52 – 53
53 – 54
54 – 55
Off Season Crop
Main Season After Off-season Cropping
Main Season After Off-season Fallow
Annual Yield Of Double Cropped Area

Table V.

Double Cropping and Manuring of Wet Padi, Bukit Merah Padi Experiment Station.

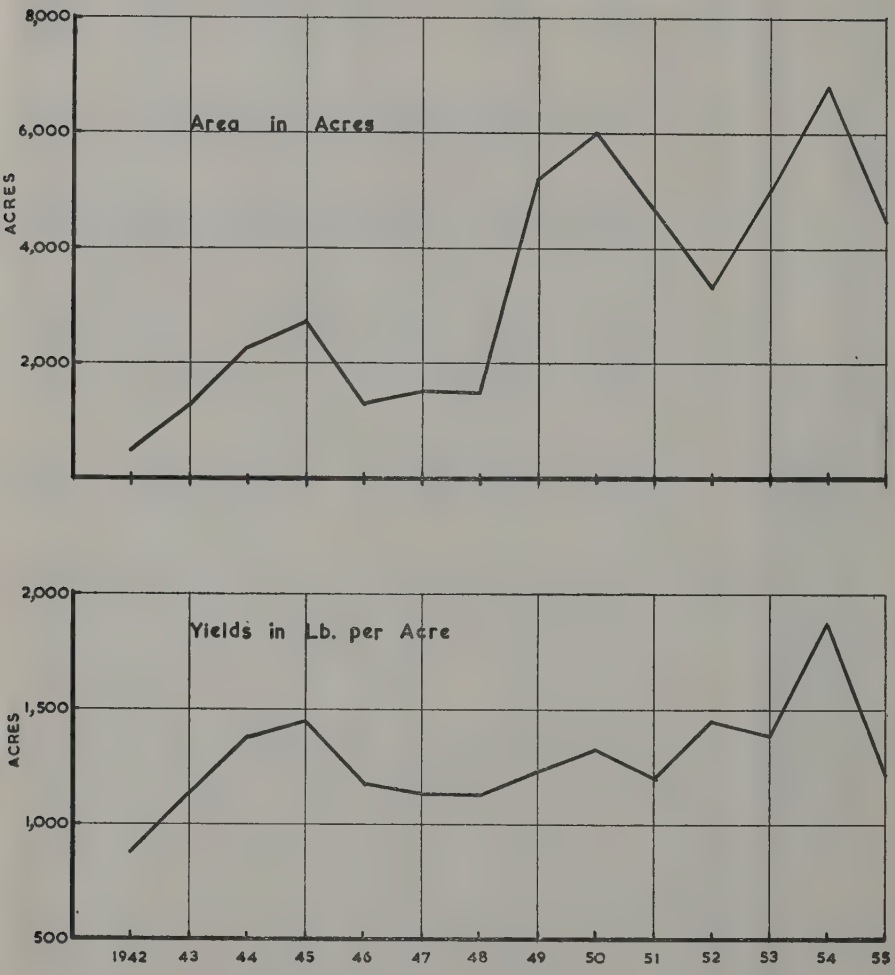
Mean Yields.

(lb. per acre)

Season	Planting Date	Harvesting Date	Variety	Main Season	Off Seasons			Mean	Remarks
					1 Fallow	2 p_0	3 p_1	4 p_2	
Off season 1947	22. 4.47	30. 7.47	Pebifun	a p_0		862	831	970	888	Treatments 3 and 4 manured with bat guano.
				b p_1		788	738	904	810	
				c p_2		842	822	1010	891	
				Mean		831	797	961	863	
Main season 1947-48	6.10.48	30.12.48	Reyong 6	a p_0	1834	1990	1928	1929	1920	Sub-treatments b and c manured with bat guano.
				b p_1	2097	2108	2065	1928	2050	
				c p_2	2007	2221	2177	2328	2184	
				Mean	1979	2108	2057	2062	2051	
1948	10. 5.48	28. 7.48	Pebifun	a p_0		1269	1266	1448	1328	
				b p_1		1291	1403	1479	1392	
				c p_2		1320	1487	1493	1433	
				Mean		1294	1385	1474	1384	
1948-49	19.10.48	13. 2.49	Reyong 6	a p_0	1588	1637	1653	1745	1656	
				b p_1	2002	1901	1900	1878	1970	
				c p_2	2030	2021	2038	2056	2036	
				Mean	1873	1854	1864	1893	1871	
1949	6. 5.49	6. 8.49	Pebifun	a p_0		1011	1021	1102	1044	Treatments 3 and 4 manured with bat guano.
				b p_1		1155	1236	1248	1213	
				c p_2		1284	1296	1360	1313	Corrected for rat damage.
				Mean		1162	1178	1229	1190	
1949-50	21.10.49	17. 2.50	Reyong 6	a p_0	1265	1115	1158	1220	1164	Sub-treatments b and c manured with bat guano.
				b p_1	1264	1182	1222	1291	1244	
				c p_2	1356	1209	1279	1447	1290	Corrected for *penyakit merah* damage.
				Mean	1309	1160	1210	1281	1240	
1950	1. 5.50	2. 8.50	Pebifun	a p_0		1044	1089	1104	1079	
				b p_1		1158	1218	1257	1211	
				c p_2		1362	1266	1359	1329	
				Mean		1188	1191	1240	1206	
1950-51	21. 9.50	1. 2.51	Radin Kelumbong	a p_0	1089	1260	1311	1350	1307	
				b p_1	1386	1302	1338	1455	1370	
				c p_2	1422	1359	1527	1644	1487	
				Mean	1299	1307	1392	1482	1370	
1951	21. 4.51	31. 7.51	Pebifun	a p_0		171	87	156	138	Treatments 3 and 4 manured with bat guano.
				b p_1		180	111	180	157	
				c p_2		249	144	234	209	Severe leaf and fruit-worm damage.
				Mean		200	114	190	168	
1951-52	7.11.51	11. 3.52	Radin Kelumbong	a p_0	1839	1593	1638	1746	1704	Sub-treatments b and c manured with bat guano.
				b p_1	2067	1914	1944	2055	1995	
				c p_2	2145	1983	2007	1962	2024	
				Mean	2017	1830	1863	1921	1908	
1952	9. 5.52	17. 8.52	Pebifun	a p_0		1080	1175	1143	1106	
				b p_1		1182	1209	1251	1214	
				c p_2		1293	1290	1287	1290	
				Mean		1185	1208	1217	1203	
1952-53	10.11.52	23. 3.53	Radin Kelumbong	a p_0	1470	1422	1365	1401	1414	
				b p_1	1567	1515	1545	1516	1543	
				c p_2	1704	1548	1563	1635	1612	
				Mean	1577	1495	1491	1517	1570	
1953	20. 5.53	28. 8.53	Pebifun	a p_0		1404	1404	1467	1425	Treatments 3 and 4 manured with bat guano.
				b p_1		1464	1503	1518	1495	
				c p_2		1506	1491	1578	1525	
				Mean		1458	1466	1521	1482	
1953-54	30.10.53	15. 3.54	Radin Kelumbong	a p_0	1734	1624	1542	1731	1677	Sub-treatments b and c manured with bat guano.
				b p_1	1737	1578	1587	1667	1641	
				c p_2	1794	1572	1641	1678	1691	
				Mean	1755	1558	1590	1717	1670	
1954	19. 5.54	28. 8.54	Pebifun	a p_0		1308	1432	1449	1390	
				b p_1		1464	1449	1485	1466	
				c p_2		1468	1642	1566	1559	
				Mean		1410	1471	1497	1439	
1954-55	31.10.54	19. 2.55	Radin Kelumbong	a p_0	1683	1560	1542	1740	1631	
				b p_1	1704	1641	1665	1680	1672	
				c p_2	1755	1593	1656	1701	1694	
				Mean	1714	1598	1621	1707	1662	
1955	19. 5.55	31. 8.55	Pebifun	a p_0		1625	1750	1706	1682	Treatments 3 and 4 manured with NPK
				b p_1		1404	1998	2291	1899	
				c p_2		1695	2079	2475	2083	
				Mean		1574	1945	2157	1881	

Fig. III.

Off-Season Wet Padi in Province Wellesley Central.



Double cropping is practised in small areas in the Settlement of Malacca and occasionally also in other States.

Discussion.

Acreages and yields of off-season padi in recent years are quoted below:

Year	Harvested Area (acres)	Total Yield of Rice (long tons)
1952	4,435	1,804
1953	7,506	3,436
1954	11,013	5,130
1955	6,257	2,329

Both the smaller area and reduced yields in 1955 were largely caused by the lack of irrigation supply in central Province Wellesley. Water, then, is the key to off-season cropping. Admittedly the above figures include a few hundred acres of dry padi but yields from such crops are always low, rarely exceeding 120 *gantang* per acre (753 kg. per ha.).

If the area under off-season padi is to expand, then clearly it will be necessary to make special provision for irrigation supply; this will cost money and may not always be feasible. Nevertheless it is now possible to say, with some assurance, that double cropping of wet padi in Malaya is a sound agricultural system provided that regular manuring is practised.

Expansion of off-season cropping will perhaps be easiest in padi areas situated on the river valley alluvia, particularly where the rivers have their sources in the mountains of the main range and have a reliable off-season flow.

Summary.

1. Attempts to grow off-season *indica* wet padi in Perak in 1936 and 1937 failed either because of severe pest damage or because of photosensitivity of the varieties used or from a combination of these two factors.

2. Short term *japonica* varieties were introduced in 1943 and these are non-photosensitive in Malayan latitudes.

3. Experimental triple cropping with the *japonica* variety Pebifun has been carried out for 18 crops at the Bukit Merah Padi Experiment Station, Province Wellesley, without deterioration in yield. The last nine crops were manured and gave a mean yield of 1,236 lb. per acre (1,385 kg. per ha.).

4. Triple cropping is not advocated in practice since this system does not permit the regular maintenance and repair of irrigation works. Furthermore, it is only possible with mechanical cultivation and at least one crop per year gives low yields because of wet weather at harvest.

5. Double cropping is now practised in several parts of Malaya but the most important area is in Province Wellesley Central where the area has increased from 525 acres in 1942 to 6,800 acres in 1954. As the area expanded so did the yield.

6. A double cropping and manuring experiment at Bukit Merah Padi Experiment Station is now in its ninth year (18th crop). Yields have been maintained by regular heavy manuring with local bat guano but increased yields are obtainable when balanced NPK fertiliser is used.

7. It can be concluded that double cropping is a sound system of agriculture in Malaya provided that fields are manured regularly and that full irrigation can be supplied to both crops, and under such circumstances it is Departmental policy to advocate cultivation of two *japonica* crops a year in order to allow the maximum time for maintenance of irrigation works.*

Acknowledgements.

The investigations here described were supervised by six different Settlement Agricultural Officers and their field staff. Full acknowledgement is made to these officers as we are well aware that the conduct of these trials required considerable persistence.

The relatively high yields obtained in recent years bear witness to the efficiency of the Drainage and Irrigation Department in supplying irrigation water out of season.

References.

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**Comment by the Drainage and Irrigation Department.*

It is not yet certain that irrigation services are or can be made adequate or that they can be adequately maintained under these circumstances.

NOTES ON CURRENT INVESTIGATIONS (RESEARCH) OCTOBER TO DECEMBER, 1955

Compiled by the Assistant Director of Agriculture (Research)

Padi.

VARIETY SELECTION.

All field experiments in the Federation have been transplanted and those with short term varieties have already been harvested at some of the Pahang and Kedah stations. In general, crops are growing well, but at Seriab, Perlis, a shortage of rain and use of over-aged seedlings will probably cause a failure of the trials. Floods at Alor Gajah Padi Test Station, Malacca, have affected part of one variety trial. Transplanting at two of the Negri Sembilan stations was considerably later than usual this season. The disease *penyakit merah* has been reported at Genting Padi Test Station, Penang, and a stem borer attack at Sungei Acheh, Province Wellesley, but trials have not been seriously affected.

Indica x Japonica Hybrids.

Pulau Gadong Padi Experiment Station, Malacca.

The general growth of pedigree lines and progeny plots has been good and no damage was sustained during the October floods. Some plants in F2 plots flowered 40 days after sowing but in later generations a more normal (up to 85 days) growing period is evident. Wide segregation is still taking place at all stages.

Telok Chengai Padi Experiment Station, Kedah.

All material was transplanted by the middle of October, and by the end of the year the earliest progenies had been harvested, the rest being in full flower. *Penyakit merah* occurred in some families only and individual lines showing a marked susceptibility to this condition have been noted.

PESTS.

Borer incidence has been found to be much higher than was hitherto suspected and field tests for control of stem borers using DDT, BHC and dieldrin are in progress. An outbreak of the Bombay Locust, *Patanga succincta*, at Lenggong, Perak, was controlled by spraying with Dieldrex 15 (0.05% dieldrin). Severe leaf damage caused by the Halticine beetle, *Chaetocnema basalis* Baly, was recorded from Trengganu.

The nematode *Radopholus oryzae* has been taken from rice roots from Perak, Kedah and Malacca, and its relation to *penyakit merah* is being studied by inoculation tests.

DISEASES.

Initial growth in field trials of seed dressed with organic mercurial fungicides in both liquid and dry form was superior, but differences disappeared within three weeks.

Dressed seed lost viability in storage as rapidly as undressed seed, but dressing of old seed produced improved germination.

NUTRITION.

Leaf sampling for analysis has been continued on experiments on peat and on fertiliser trials on normal soils. Samples from areas affected by *penyakit merah* showed a wide variation in phosphorus content.

SOILS.

In spite of liming, the plants in the Malacca 'gelam' soils in tanks at Headquarters, Kuala Lumpur, have shown poor growth, the poorest being in the tank with 10 tons of lime per acre. Water samples have been collected at regular intervals for pH and sulphate determinations. The best growth has been in the tank with the smallest dressing of lime, i.e. 1 ton per acre. All plants show signs of deficiency, possibly magnesium. The crop in the tanks being used to study the effects of different degrees of off-season drainage and growing season stagnation is nearly ready for harvest. There are no startling differences in growth.

Survey of soils in potential padi areas at Changkat Jong and Trans-Perak have been continued.

Cacao.

SELECTION.

Altogether, 9,395 pods were harvested from experimental areas at the Federal Experiment Station, Serdang, during the quarter. Field 45A at Serdang is being progressively planted with plots of five cuttings taken from each of the selected trees. This 'museum' is unreplicated but is interplanted with Amelonado plots. By the end of the year, 42 Trinitario clones and seven Amelonado controls had been planted.

At the Federal Experiment Station, Jerangau, two acres of the six-acre clonal selection block was planted by the end of October. Each of 90 selected Trinitario trees at Serdang was established in two plots of 12 trees each.

The first 1½ acres of the 11-acre progeny selection block was planted in November. This trial is designed to test 13 new progenies and an Amelonado control.

PROCESSING.

The effect of variation of temperature and time on bean fermentation is being investigated. Cocoa butter has been extracted and deodorised by various methods and the fat compared favourably with standard samples.

PESTS.

Spraying with dieldrin (1.5% actual) reduced the frequency of bore holes due to *Zeuzera coffeae* Nietn. by 66 per cent.

The clear wing moth, *Conopia* sp., has been recorded in Trengganu where, so far, the pods and not the stem are attacked. Damage

to seed is not serious and only pods previously attacked by *Helopeltis theobromae* Miller are affected.

DISEASES.

Calcium deficiency in sand cultures, after seven months, has caused severe stunting and reduction in the number of leaves. Lack of magnesium and potassium has also caused stunting and, too, severe leaf necrosis. A survey of cacao diseases has been commenced and records for the Federal Experiment Station, Serdang, include *Gloeosporium* leaf spot, white threadblight and die-back associated with *Nectria* and *Fusarium* spp. White threadblight occurred in one area in Kelantan. Pink disease *(Corticium salmonicolor)* caused damage to one tree in Trengganu. This is the first recent record of pink disease on cacao, although it was first recorded in 1914. Pink disease has also been found during the quarter on calabash *(Crescentia cujete)*.

SOIL SURVEYS.

Surveys of potential cacao areas have been completed around Jerangau and Ulu Chalok and commenced at Sungei Tebak; all areas are in Trengganu. Details of these surveys are to be published later. The soils in the Jerangau area are derived from the finer grained granites. Similar surveys are in progress adjacent to the Maran Road in Pahang.

Oil Palm.

SELECTION AND BREEDING.

Results from unreplicated observation plots of backcrossed dumpy palms indicate that progenies of palms 12/3 and 1/1 seem to be the earliest in bearing and those of 1/7 and 14/2, like their parents, have relatively large bunches. Yields of the two experiments (0.5 and 0.6) in Perak are now being recorded.

Pollen has been obtained from high yielding short palms of various estates and used on dumpy and semi-dumpy palms at Serdang. Pollination technique at Serdang has been considerably improved by adoption of more stringent measures to avoid accidental out-pollination occurring.

PROCESSING.

In the study of effects of processing on palm kernel quality, pressure cooking tests and subsequent drying tests are being continued. A comparison of the oils from *dura* and *tenera* palms is being carried out.

NUTRITION.

Work has been continued on the analyses of 506 samples of frond taken from palms of different ages on estates on deep peat, shallow peat and muck, coastal clay, and inland soils derived mainly from quartzites and shales. On one estate, samples of fronds 3, 9, 17 and 25 were obtained and are being used to study nutrient gradients. It appears that nitrogen content is very constant regardless of soil type or age of palm,

and there is very little difference between fronds 3 and 17. Frond 25, however, shows a very marked drop. The ash content varies quite widely from one area to another.

Coconut.

SELECTION.

Harvesting of nuts from selected trees at Port Swettenham continues. Altogether 325 germinated nuts were sent to the Federal Experiment Station, Telok Bharu, Perak, during the quarter.

Pineapple.

SELECTION.

The first fruits in selection blocks of Singapore Spanish clones at the Federal Experiment Station, Alor Bukit, Johore, have been harvested but, owing to lack of staff, it was not possible to take yield records.

PROCESSING.

Fruit analyses have shown that the Sarawak and Smooth Cayenne varieties are similar and have a higher sugar content than Singapore Spanish. The difference can, however, be minimised by potash manuring which also increases titratable acidity and hydrogen ion concentration in Singapore Spanish.

Analysis of 40 tins of locally grown Smooth Cayenne showed composition to be similar to imported samples. No differences were found between the canned fruit from five strains of Smooth Cayenne plants imported from Australia.

A series of experiments has been commenced to compare quality and yield in can of the four varieties Singapore Spanish, Sarawak, Selangor Green and Mauritius. A total of 892 cans from 1,020 fruits weighing 3,216 lb. has been laid down.

NUTRITION.

Leaf analyses of material from a potash manurial trial showed a marked potash deficiency in plants in control plots, the potash apparently being replaced by magnesium. The quantity of potash applied has little effect on the potash or magnesium content of the plants.

PESTS AND DISEASES.

Mealy-Bug.

In pot experiments in which plants were inoculated with mealybugs collected from unwilted and wilted pineapples, symptoms of quick wilt appeared only in the latter. The possibility of a virus being present is under investigation.

Fruit Collapse.

Fruit was found to be susceptible to infection by the causative bacterium at all ages but susceptibility is reduced as the fruit ripens. The variety Sarawak has proved resistant whilst Singapore Spanish, Selangor Green and Mauritius are equally susceptible.

THIELAVIOPSIS.

A basal rot of pineapple suckers caused by a species of *Thielaviopsis* was found at the Federal Experiment Station, Jalan Kebun; about 2 per cent of the suckers were affected.

Other Crops.

BANANA.

In a survey of leaf diseases in the variety collection at the Federal Experiment Station, Serdang, *Cordana musae* was found on 20 varieties and *Cercospora musae* on 14 varieties, while both fungi were found attacking 24 varieties.

GRAPEFRUIT, ETC.

Two samples of grapefruit, variety "Gillot Late," from the Federal Experiment Station, Gajah Mati, Kedah, were analysed. The results compared unfavourably with fruit grown overseas.

Fruit preservation by deep freezing is being investigated with mangosteen and five rambutan clones.

SWEET POTATO.

In a small field trial, aldrin at 0.1 per cent actual (Aldrex 2 at 1:200) was effective against the weevil *Cylas formicarius* F. Only 4.5 per cent of the tubers from the sprayed plots were badly damaged compared with 36 per cent from the controls.

TOMATO.

An experiment to discover whether bacterial wilt of tomato can be controlled by streptomycin has begun.

GROUNDNUT.

Two selection blocks, each containing 125 strains, have been replanted and growth, especially in one block, has so far been excellent.

TEA.

Three fungicidal spraying experiments were laid down in October to test two copper fungicides and two organic fungicides against Blister Blight.

COFFEE.

Local coffee beans (variety Liberica) produced on a muck soil in Selangor were roasted and the coffee made was found to be satisfactory.

CLOVE.

An experiment on the control of *Valsa eugeniae* and *Cryptosporella eugeniae* is being laid down in Penang. *Cryptosporella* die-back was found on cloves and *jambu ayer* at Sungei Udang Agricultural Station, Malacca. It is now obvious that this disease is widespread in Malaya, but *Valsa eugeniae* has not been found outside Penang.

Laboratory Investigations.

Base Exchange.

Further work on the barium chloride buffered with triethanolamine method has confirmed that this is the most promising so far tried for exchangeable bases determination.

"Soluble" Potassium.

Tests of soil extraction methods using 0.5 N acetic acid show little effect of time of shaking, one hour being satisfactory; and a ratio of 10 gm. of soil to 100 ml. of solution gives good differentiation between soils.

Soil Phosphorus.

Total and exchangeable phosphorus are being determined by using sodium zeolite. Variation in phosphorus fixation in wet padi and various types of upland soils is being studied. Also under examination are the methods of determining the phosphorus in the extract with particular reference to interference of silica in the development of the molybdenum blue colour.

Routine Analysis.

Chemical analyses undertaken have covered samples of grasses including Elephant and Guinea grasses, lalang *(Imperata cylindrica)*, *Panicum trichocladum* and *Centrosema*, as well as rolled oats, chick mash, fish meal, eleven types of manures and fertilisers, irrigation water, jelutong, seven arsenic determinations, and numerous oils, oil seeds and residues, and over 1,000 soil samples.

Miscellaneous Pests.

Miscellaneous pests identified included the chafer *Anomala Shanica* Arr. on grass under tea at Cameron Highlands; caterpillars of the Pyralid *Agathodes ostentalis* Hb. in shoots of dedap *(Erythrina subumbrans)*; caterpillars of the Metarbelid *Indarbela flavina* Mell on bark of *Peltophorum*; and the flattid bug *Lawana conspersa* Walk. on twigs of *Casuarina equisetifolia*. Endrin at 0.05 per cent gave good control of the last named insect against which nicotine sulphate was ineffective.

Soil Survey.

In addition to surveys already referred to, the Sungei Bilut Valley near Bentong, Pahang, which is scheduled for early development, was examined. In spite of records of the occurrence of basic volcanic rocks in the area, only soils of lower fertility derived from quartzites and shales were found.

NOTES ON CURRENT INVESTIGATIONS (AGRONOMY) OCTOBER TO DECEMBER, 1955

Compiled by the Senior Agronomist.

Padi.

During the post-war period from 1948 until the present, intensive studies on double-cropping of wet padi have been carried out at the Bukit Merah Padi Experiment Station, Province Wellesley, and these have recently been reviewed for publication.

The short-strawed variety Engkatek is proving to be of outstanding agronomic importance: it is highly resistant to lodging and should be ideal for mechanical cultivation. This resistance to lodging has not broken down under fairly heavy manuring and the variety has grown very well indeed from Malacca to north Kedah. The potential importance of Engkatek is two-fold: it is comparable with the short-strawed "combine" wheat and barley varieties of Western countries and it makes it possible to practise heavy nitrogenous manuring in the localities where response to this nutrient is known to be linear.

It has been a bad year for rat damage and many trials in Malacca, Negri Sembilan and Province Wellesley have been affected. The disease *Penyakit Merah* has also been widespread at the Bukit Merah Padi Experiment Station. At this last station plans have been made to study the effect of sub-soil drainage in the light of the great success of mole drainage in Malacca.

A dressing of five tons per acre of cattle manure is reported to have had an outstanding effect on the growth of dry padi at Kampong Pusu in Kelantan.

The fifth meeting of the International Rice Commission Working Party on Rice Breeding was held in Penang from December 5th to 11th contemporaneously with the sixth meeting of the Working Party on Fertilizers and some items were discussed in joint session. This meeting was convened by the Food and Agriculture Organization of the United Nations, and the Working Party on Fertilizers was attended by 26 participants representing 12 governments.

Five special papers on agronomic subjects were prepared for the meeting as follows:—

1. The Effect of Crop Rotation on Growth and Yield of Padi.
2. Double Cropping of Wet Padi in Province Wellesley.
3. I.R.C. 6-plot Fertilizer Trials on Smallholders' Land, Federation of Malaya.
4. N.P.K. Factorial Trials on Wet Padi in Malaya.
5. Wet Padi Manurial Experiments on Peat Soils in Malaya.

A sixth paper was written for a co-ordinated study of the interaction of fertiliser response with varieties.

Ten large Departmental photographs of padi agronomic investigations, each 20 x 24 in. in size, were on display and evoked considerable interest from delegates.

The meeting was held in the St. George's Girls' School, Penang, which proved to be an ideal venue. Visiting delegates expressed considerable admiration for the arrangements made for this meeting.

Cacao.

The new leaflet which summarizes the latest information on cultivation of this crop has now been printed. A somewhat simpler version in Chinese has also been issued and a Malay leaflet is in the press.

It will be remembered that the NPK factorial manurial trial which was planted with Trinitario material at Jerangau Estate, Trengganu, in September, 1951, showed that phosphorus was the key nutrient element as far as early growth was concerned. Yield figures for this trial have now been received for the period up to the end of 1955 and analysis has revealed a linear response from phosphorus but from no other element. Naturally these yield figures are considerably influenced by early growth, and arrangements have been made in another field experiment to study the manurial requirements of mature Amelonado cacao which has received uniform phosphatic manuring during the first three years of growth.

An Agronomist was posted to the Federal Experiment Station, Jerangau, in early October for full-time duty there.

Amelonado cacao which was planted at about 12 x 15 ft. spacing in July, 1953, under 1929-planted tall coconuts on an estate in Lower Perak has shown very promising growth indeed. Even on this rich alluvial clay it would seem that phosphatic manuring is essential for healthy early growth and that manuring with NPK leads to unbalanced nutrition. The spacing of the coconuts is 29 x 29 ft. triangular and no secondary shade has been planted. Equally promising growth has been noted on the same estate under dwarf coconuts.

A small but important manurial experiment on Amelonado cacao was planted at the Federal Experiment Station, Jerangau, in September, 1954, and girth measurements taken in November, 1955, have shown that a combined dressing of Christmas Island rock phosphate and ground magnesium limestone has led to better growth than single or double dressings of either fertiliser alone.

At Serdang, Selangor, considerable use is being made of seedlings of *Indigofera teysmanni* in soil blocks to provide quick secondary shade for new experimental plantings of cacao.

An important 17-acre establishment trial was cleared at the Federal Experiment Station, Jerangau, during the quarter in order to test four different techniques of establishing Amelonado seedling cacao with cultivated shade. Fifteen acres of land has been felled, partially burnt, lined and planted with the necessary shade trees. In this area the cacao will be planted in one year's time. The balance of two acres has also

been cleared and planted with dry padi and maize with cacao underplanted at a spacing of 6 x 6 ft. The cacao is now well established in spite of some early leaf-scorch soon after planting out.

Coconuts.

Main and field drainage of 45 acres of the new Federal Experiment Station at Teluk Bharu in South Perak was completed in December. All drains were excavated mechanically on contract and the quality of the work was excellent although it took longer than had been expected. Unfortunately the drainage is slow to become effective, possibly because of the mechanical eradication of lalang *(Imperata cylindrica)*, and it has not yet been possible to plant out any selected seedings. With this particular soil-type it is essential not to plant until holes can be filled with weathered topsoil.

Oil Palms.

Six acres, representing two blocks of a new variety trial, was planted in December at the Federal Experiment Station, Jerangau. Unfortunately adverse weather conditions affected the burn, so the balance of the experimental site will have to be cleared in February.

Two co-operative manurial trials on estates in Perak and Selangor are being well maintained but it is too soon to expect results of interest.

Pineapples.

At the Federal Experiment Station, Jalan Kebun, Selangor, Sarawak pines in a ridging and spacing trial have given the best yields from close-spacings on the flat. Actual yields and average fruit weights for the period 17th January to 7th August, 1955, are given below:—

Spacing	Yield of Fruit per Acre (lb.)	Average Fruit Weight (lb. oz.)
6 x 2 ft. flat	598	6 9
6 x 2 ft. ridged	383	5 12½
2 x 2 ft., 3 rows, 6 ft. apart, ridged	542	5 6½
2 x 2 ft., 3 rows, 4ft. apart, flat	1,138	5 1

In a trial to test the relative value of applying fertiliser either as a nutrient spray or as a dry dressing to the soil, the second spray application to the foliage was given in November. So far, the plots receiving the dry application have shown the better growth.

Similar trials are in progress with Sarawak and Mauritius pines growing on coastal sands of the East Coast. On this *bris* land, Sarawak seems to be the better variety to grow.

At the Federal Experiment Station, Alor Bukit, in south Johore, the clearing of the first block of 10 acres of land for mechanisation trials has been completed.

Manila Hemp.

Poor growth in a variety trial at Sungei Burong on the Selangor coast has been associated with a high salt content in the soil at a depth of one foot and the experiment has now been abandoned.

Coffee.

Surface subsidence of deep peat at Jalan Kebun has caused some root exposure of Liberian coffee in two manurial experiments. Of the major elements, potash is clearly of greatest benefit in the production of good shaped bushes with leaves of healthy colour and size. Absence of potash causes chlorosis and occasional necrosis: leaves are small and thin and often curled upwards. Surface burning is also of value to a lesser degree and phosphate is probably beneficial. Liming at 10 tons of ground limestone per acre is excessive as all plots show leaves of a yellow colour. Nitrogen is possibly harmful as it appears to suppress branching.

Tea.

In the second year of an NPK manurial trial at Cameron Highlands there has been a response in yield to both 80 lb. per acre of nitrogen, as sulphate of ammonia, and 30 lb. per acre of P_2O_5, as Christmas Island rock phosphate. Potash had no measurable effect. The mean yield for the whole trial was 749 lb. per acre of made tea; that for the NP plots was 792 lb. per acre.

This result ties up well with those from a nitrogen trial at the same locality where the basal manuring consists of 30 lb. per acre per annum each of P_2O_5 and K_2O. In the third year, yields of made tea were as follows:—

nitrogen dressing (lb. per acre)	0	40	80	120
yield of made tea (lb. per acre)	634	713	740	824

NOTES ON EXTENSION WORK
OCTOBER TO DECEMBER, 1955

Compiled by the Assistant Director of Agriculture (Field).

Rubber.

The main planting season of the year occurred during the quarter. Altogether 2,843,470 clonal stumps were delivered to the Rubber Industry (Replanting) Board for distribution to approved replanters and a further 1,163,061 stumps went to those new planting. These figures bring the totals to-date this year to 4,625,366 stumps for replanting and 1,365,709 stumps for new planting as compared with 3,105,220 and 213,423 stumps last year.

For the first time since distribution of clonal stumps was organised on a large scale, there was a surplus of stumps and it has been possible to meet the whole of the requirements of both replanting and new planting.

Prospects for 1956 are particularly encouraging for in addition to the stumps that will become available from seed sown during the year, some one million stumps from 1954-55 plantings will also be available.

The replanting programme this year has not been as successful as was hoped, but this is due almost entirely to the high price of rubber, which naturally deters smallholders from cutting out their old trees. By the end of the year the acreage replanted was estimated at 26,000 acres as compared with a target of 60,000 acres.

During the quarter 32,339 yards of budwood of approved clones was delivered to the Replanting Board and 12,726 yards distributed to new planters. These figures bring the totals for 1955 to 120,490 yards and 61,490 yards respectively.

Clonal seed from approved sources became available in quantity during the quarter and over 11½ million Tj. 1 seeds were collected and sown in nurseries under the control of the Department. This material will become available to meet the needs of the Replanting Board as well as new planters. In some States, especially those interested in new planting, separate nurseries for new planting have been laid down and are being financed by the State Governments, but this practice is merely to ensure an equitable distribution between new planting and replanting needs. All surplus material from either type of nursery will be readily interchangeable.

The total number of clonal seeds collected this main seed fall was approximately 23 million, an increase of about 10 million over 1954.

The search for new sources of clonal seed continues and very good progress has been made. In Johore, where there is now some 2,570 acres approved, a further 1,860 acres is under examination and 2,480 acres yet to be examined. From these local sources this season some two million seeds were collected, representing approximately two-thirds of the total State requirements.

On the other hand, in Pahang, which has been a fairly large supplier of seed, careful examination by Rubber Research Institute experts of the fields on the approved estates has revealed much admixture with seedling rubber and non-approved clones. Until these have been destroyed, such areas will in future not be used and Pahang's needs will be met from outside sources.

Many applications for land for new planting are reported from most Land Offices and the acreage actually planted during the last quarter of the year is estimated at over 4,200 acres. This desire for new land must be expected, for although a large number of the older members of smallholders' families possess rubber land, the younger generation are mainly without. The continuing high price of rubber still makes it the first choice of crop for new areas.

Strenuous efforts are being made by officers of the Department of Agriculture and of the Rubber Research Institute to get all these new areas planted up with approved high yielding clones; in many States it is compulsory by law to do so before a title is issued.

In Kedah and Perlis, however, uncontrolled planting is still going on and it is estimated that at least 5,000 acres is planted annually with ordinary unselected seedlings. This problem is slowly being tackled and during the quarter selected planting material for over 500 acres was supplied.

It is interesting to note that there is a marked indication that smallholders are beginning to realise that controlled block development of areas is vastly superior to a large number of individual efforts. A few of the schemes now in progress are:—

(a) The aided rubber scheme in new villages in Ulu Kelantan, where 620 acres has been planted;

(b) The three primitive resettlements in Kedah where demonstration plots measuring one relong (.71 acre) each have been established and a further 25 relongs have been renticed and prepared for planting;

(c) Bagan Bharu Special Constable Scheme, Perak. A total area of about 250 acres of virgin jungle, of which approximately 120 acres has been felled, cleared and planted;

(d) The Seremban Rubber Land Development Society, Rantau, which has felled, cleared and burnt 200 acres; and

(e) The Lenggeng Better Village Club which has planted 20 acres out of the 80 acres to be planted.

In Kedah, 202,292 lb. (dry rubber content) of latex, valued at $186,655, was collected during the quarter as compared with 215,759 lb., valued at $178,890, last quarter. In Perak, 493,800 lb. was collected.

Centralised rubber processing factories appear to suffer more than latex collecting centres from lack of loyalty to the scheme: two closed down in Perak but another opened up.

During the quarter, the Rubber Industry (Replanting) Board

called for applications for replanting during 1956 and returns have been considerably above those received for 1955, but it remains to be seen how many areas will eventually be planted. There is little doubt, however, that replanting together with new planting will create a new record. The Department is well placed to meet this demand with its 12 to 13 million clonal stumps plus enough budwood for 29,000 acres.

Padi.

Wet Padi. 1955-56 Season, Main Crop.

The estimated acreage that is expected to be planted this season is 823,000 acres, as compared with 832,580 acres during the 1954-55 season: by the end of the quarter, 98 per cent of this had been planted. Areas that have been particularly badly hit by dry weather and lack of water are the Sungei Burong and northern parts of the Tanjong Karang padi area in Selangor and the late planted areas in Kedah and Perlis. There has also been a drop of some 3,700 acres planted in Trengganu.

Lack of sufficient water at the critical periods of nursery establishment, land preparation and transplanting has resulted in widespread use of over-age seedlings, and this factor alone will result in a considerable reduction in yields.

In Kedah, the State that produces 40 per cent of the total Malayan crop, the average yield is estimated at 325 gantangs (gallons) per acre as compared with 379 in the 1954-55 season and 404 and 433 gantangs in the 1953-54 and 1952-53 seasons.

In Kelantan and Trengganu, harvesting of the 'Menghulu' crop was carried out under ideal weather conditions and yields were satisfactory. Johore, which is usually regarded as a State where padi is seldom grown and crop yields are extremely poor, is at long last beginning to make some progress. This season so far, a total of 9,190 acres has been planted, as against 9,250 acres last season, but what is of interest is that, at Kahang, yields of up to 520 gantangs per acre have been recorded from the Department's Padi Station, as compared with 180 gantangs per acre on cultivators' lands, the low yields being mainly due to the use of over-age seedlings.

Economics.

A recent survey carried out in Perlis by the State Agricultural Officer has produced evidence in support of what has long been known by agricultural officers and others closely connected with padi cultivation that padi planting today is one of the poorest and least remunerative of businesses in Malaya.

This census shows that 62.3 per cent of the padi farmers are working Class I land, 34.4 per cent Class II and 3.2 per cent Class III. The average size of a holding varies both with race and with the class of land, relative figures being as follows:—

In Relongs

	Percentage of Cultivators	Class I	Class II	Class III
Malays	93.5	7.2	5.2	4.5
Chinese	3.8	12.0	6.3	Nil
Thais	2.7	9.5	7.0	4.3

The number of dependants varies by race from 4.09 to 4.46.

The most important economic factor is the rent charged for the land, which even under the new Padi Cultivation Control of Rent Ordinance is one-third of the total crop. As 41.4 per cent of the padi farmers are tenants, this is a vital matter.

The most striking point that arises from this survey is the return from an average crop. Until a full economic survey has been carried out, it is only possible to make a rough estimation of such items as the value of a cultivator's own labour, the amount of rice he and his family consume during the year and other similar points but after allowing for these, it has been calculated that the cash value of surplus padi obtained by the various types of farmers per holding is as follows:—

Class I Land.

Malay tenant $189. Malay owner $561. Malay owner/tenant $542. Chinese tenant $505. Chinese owner $1,227.

Class II.

Malay tenant $123. Malay owner $260. Malay owner/tenant $320.

Class III.

Malay owner $76.

The Chinese do not work Class III lands.

All the above figures are based on a padi price of $14 per pikul (133 1/3 lb.).

The above figures clearly indicate that unless a padi farmer has some other work, which he seldom has, or can supplement his income, he is very badly off when compared with other agricultural workers.

A similar census has been carried out in Kedah and is now being analysed. It is now certain that conditions in that State are no more favourable than in Perlis and will probably follow the same trend.

In December, the Federal Government agreed to raise the guaranteed minimum price for clean, dry padi delivered at mill door from $12 to $14 per pikul. This had the effect of raising the local price in Kedah from $12.75 per pikul for the new season crop in the last half of November to $16 per pikul in the first half of December and $13.30 in the second half.

Short Term Varieties.

Harvesting of short term varieties in Perlis, Kedah and Kelantan was completed during December. Crops in Kedah were somewhat

adversely affected by the wet weather in November which caused some lodging, but there was little real loss of grain.

Owing to loss of nurseries, and the very late season, there has been a heavy demand for short-term padi varieties and full advantage has been taken of minor disasters to distribute selected varieties. For instance, in Malacca, where floods destroyed some 150 acres of newly transplanted padi in October, the Department distributed seedlings of a short-term Taiwan variety from nurseries especially established for the purpose. A total of 5,650 bundles (untings) of seedlings were so distributed.

In the double-cropped area of Province Wellesley, between 10 and 15 per cent of the fields have been planted with Taiwan varieties. This is agreed policy in an endeavour to get the planting dates corrected by planting two short term varieties in lieu of a short term plus a medium term variety.

USE OF SELECTED VARIETIES.

After many years of hard propaganda by the field officers of this Department, some progress appears to have been made with regard to the use of selected varieties, especially in Malacca and Negri Sembilan. In the latter State it is estimated that this season some 1,400 acres has been planted with selected Serendah strains.

The most advanced of the States and Settlements in this respect is undoubtedly Malacca where there are some 60 selected padi seed farms. Unfortunately two of these areas were lost during the floods, but this will not affect seed supplies for next season, as improved yields can be expected from the other farms as the result of better cultivation and manuring.

Last season in Perak it was noticed that certain varieties, notably Seri Raja and the Java padi Banggawan, showed considerable resistance to the disease *penyakit merah*. The local cultivators have been quick to take advantage of this and gladly agreed to put down 64 test plots with Banggawan and Seri Ayer varieties. However, *penyakit merah* has been little in evidence this season, so it will be impossible to judge the value of this piece of extension work.

During the quarter a total of 1,351 gantangs of selected seed was distributed.

FERTILISERS.

Considerable progress has been made this year in popularising the use of fertilisers. In Kelantan, Trengganu and Malacca, fertiliser schemes are in operation whereby manures are subsidised to the extent of 50 per cent of the total cost. This has been made possible by utilising a part of the money which has been made available by the Federal Government under the 'Assistance to Padi Farmers' bill.

The oldest of these schemes is that in Kelantan, which is now in its fourth year. Here, a total of 820.6 tons was distributed, an

increase of slightly more than 100 tons over the best previous year (1953). In Malacca, where the scheme is so organised that the Department makes available bulk supplies to central depots for re-distribution by the local Rural Councils, some 136 tons of a basal phosphate/potash dressing and some 151 tons of sulphate of ammonia for top-dressing the growing padi have been distributed. The Trengganu scheme was started very late in the season and it was only possible to distribute 47 tons, but 15 tons was illegally smuggled over the border from Kelantan.

In addition to these organised schemes, considerable quantities of fertiliser have been used in Province Wellesley, Kedah, Perlis and, to a lesser extent, in Perak.

It is difficult to estimate how many acres of padi land has been manured this season, but it is known that probably less than 5 per cent of the lands outside of Kedah and Perlis that should be manured do get any dressing. There are two main reasons for this, firstly the lack of appreciation by the cultivators of the value of manures and secondly the inability of many, especially those farming second and third class lands, to afford the price of the manures.

Experiments have now proved that over 60 per cent of padi lands in Malaya respond to fertilisers, and that the lighter and less fertile the land and the higher the standard of farming, the greater the response. Responses of 100 gantangs (gallons) per acre with padi at $14 per pikul (133 1/3 lb.) can usually be regarded as economic.

In such areas, officers of the Department are conducting a large number of experiments designed to determine the degree of response to fertilisers and the most economic mixture. Such experiments, which are being conducted on cultivators' own lands, are serving another purpose in that they are fast becoming demonstrations and centres of attraction. This season, over 2,400 such experiments have been laid, covering all States and Settlements.

Some of these experimental plots combine the use of selected varieties, so the local cultivators can see for themselves the effect of fertilisers on their own local varieties and on selected varieties.

PESTS.

The major pests that have been reported during the quarter have been *Leptocorisa acuta* Thunb. in Kelantan, which has been successfully controlled by fogging with Dieldrex 15, *Nymphula* sp. in Malacca, controlled by flooding and dusting with B.H.C., and an attack of *Patanga succincta* (Bombay Locust) on 300 acres of dry padi at Ulu Gali, Pahang, which was controlled with Agrocide dispersible powder and Agrocide 3.

DRY PADI. 1955-56 SEASON, MAIN CROP.

The total acreage planted by the end of the quarter amounted to 50,500 acres as compared with 47,300 acres in 1954. Crop prospects in all States and Settlements were reported as satisfactory except where the crop had been grown in small isolated patches, which are very prone to damage by birds.

In the Paya Besar Development Scheme, Kuantan, Pahang, 135 acres has been planted this season comprising the 50-acre block opened last year plus 85 acres of new land brought in this season. On the 50-acre block, all cultivations (by tractor) were undertaken by two of the participants of the Scheme who had been specially trained by the Department.

In Trengganu, there was a decrease of 1,000 acres in the area planted on account of the prolonged dry weather and 600 acres being coverted to wet padi. The Kuala Akob Dry Padi Scheme, Trengganu, has made considerable progress and a yield of about 250 gantangs per acre is expected, which is over 100 gantangs more than the average yield of dry padi in the State.

Altogether, 30 fertiliser extension and five variety trials have been laid down on cultivators' lands in Trengganu.

GENERAL.

During the quarter, rapid progress was made in Kedah with the formation of the Kedah Padi Planters' Board and the Padi Planters' Association.

The Kedah Padi Planters Board Enactment became law on the 26th December. This is a very important enactment as it allows, amongst other things, for all the money voted by the Federal Government to assist padi planters to be used for such purposes as combating the evil of 'Jual Janji' (land mortgage) and for general assistance to planters.

Another great step forward was made in the State when it was decided to form the Padi Planters' Association and to arrange for Divisions of the Association in the 18 areas proposed by the Kedah Rice Committee. Good progress was made during the quarter and rules for both the Association and its Divisions and Branches have been drawn up and approved by the Registrar of Societies.

The economic surveys being conducted by the Agricultural Economist have entered their final stages in Kedah, Perlis and Province Wellesley. In Kelantan, the first stage is nearing completion. All surveys will be completed by the end of 1956.

Coconuts.

There was a small rise in the prices of copra and nuts during the quarter, the price of the former averaging $25 per pikul and the latter $10 to $12 per 100.

In Kelantan, 1,500 seed-nuts have been distributed by the Department to the resettlement villages in the Pergau Valley in Ulu Kelantan. Arrangements have been made in Province Wellesley to supply 1,200 selected seed-nuts at 20 cents each from a well-known and high yielding European-owned estate to those smallholders who wish to replant or establish new holdings.

In Johore, the survey which is to be carried out to determine the extent of damage to smallholdings by sea-water and poor drainage

has been fully planned and is due to start early in 1956. If this survey is successful, similar surveys will be arranged for other coconut areas in the country.

Coffee.

News of extension of this crop comes from Johore, Kelantan, Selangor and Negri Sembilan. The acreage is small, except in Selangor where some 1,500 acres has been added during the year. At present, local prices are high, $40 per pikul of berries or $235 per pikul of beans, but world supplies are known to be increasing rapidly and are bound to affect the Malayan market in the near future, even though all coffee is being consumed on the local market. In the Klang district of Selangor there is a welcome move to interplant coffee holdings with coconuts and fruit trees, and this is being encouraged.

Food Crops and Vegetables.

In Malacca, some 200 pikuls (26,666 lb.) of vegetables were exported to Singapore during the quarter. Growers in Johore, however, are slowly increasing their production and many are now coming to the Department to purchase fertilisers at subsidised prices. A total of 58 tons was thus sold during the period.

Production of tapioca appears to be maladjusted. In Province Wellesley the local factories had to import roots from Kedah and Perak to keep going. The acreage has increased in the Sungei Siput and Chemor areas of Perak (in spite of difficulties with the authorities over illegal planting and control of food supplies to the terrorists) but is decreasing elsewhere in the State.

In Johore, sago is stated to be as profitable as rubber, with sago palms selling at $10 per trunk.

From Selangor comes the story of a Chinese cultivator in the Sekinchang area of Tanjong Karang who is said to have realised $8,000 from his three-acre lot cultivated with brinjal. This may be an exaggeration, but the fact remains that he has now quit the area and invested in a rubber holding.

From the same State, a severe attack of Phyllotreta (Flea beetle) is reported as causing considerable damage to Choy Sum; this resulted in a reduction of crops and an increase in price.

In Penang and Province Wellesley the system of growing vegetables on the padi bunds as an intercrop between the growing padi is slowly spreading and considerable quantities were harvested during the last part of the quarter.

Tobacco.

The main tobacco producing areas completed harvest during the quarter. Quality was poor, as is usual at the tail-end of the season. In Kelantan, there is a considerable amount of tobacco grown, but the bulk of the product is manufactured and consumed locally; it is usually of very low quality when compared with that grown by the Chinese in the Upper Perak and Changkat Jong areas of Perak.

Fruit.

The need for adequate marketing facilities is clearly shown from the prices obtained for durians in the Parit area of Perak as compared with those obtained in Negri Sembilan. In Parit, durians fetched between 28 and 35 cents per fruit, while in Negri Sembilan the kampong price was 25 to 70 cents and the town price 50 cents to $1.20.

The area under Mandarin oranges continues to expand and a further 40 acres was planted in Perak and five acres in Negri Sembilan.

Banana production has increased considerably as the result of rubber replanting, 2,270 acres being planted during the quarter in central Perak and large areas in Negri Sembilan. In the Parit district of Perak they became unsaleable during the height of the durian season.

The production of selected high yielding budded fruit plants continues both by the Department and by private concerns under the strict supervision of the Department. A total of 15,880 plants was sold from Departmental nurseries during the quarter, but from private sources there were at least another 4,000 plants.

Supplies from some of the commercial nurseries were as follows:—

Sungei Siput nursery run by Chinese 2,300 plants; four small, kampong nurseries in North Perak, established for the sole purpose of supplying plants for filling vacancies and replacing dead and useless trees in the surrounding kampongs, 1,000 plants.

In Johore, there are now 18 rural commercial nurseries, two new ones being added during the quarter. Commercial nurseries have also been established in Selangor, but are not yet in production.

In Province Wellesley, a start has at long last been made in opening up Kampong Selamat. The land has been held unopened since 1928. During the quarter, 200 budded trees were established.

Manuring of fruit trees with a NPK mixture in Johore is reported to be a success.

Pineapples.

The acreage under pineapples being grown for supply of fresh fruit is slowly increasing and new areas have been opened up in the Dindings in Perak and in Province Wellesley.

During the quarter a further 100,000 Singapore Canning suckers were supplied to the smallholders' area at Kampong Selabak in Perak. This area is progressing fairly well and there is a keen demand for new land. The area is being developed as a source of supply of fruit to the nearby cannery.

In Selangor, the cannery has tightened up on the purchase of sub-standard fruit produced by smallholders. This has been possible by increased supplies of fruit coming in from their own plantations. This action should have a beneficial effect and should result in smallholders taking more care of their holdings and replanting their worn out areas.

In Johore, two manurial demonstration plots have been laid down on smallholders' lands at Ayer Hitam to demonstrate the manuring of old pineapples. There are also plots demonstrating general planting and maintenance methods.

In the Pontian district of Johore, 500 acres of land alienated to Malays in the Peradin Malay Reservation has been leased to Chinese. Some 100 acres has been planted to date. This leasing of land is a common method adopted by Malays who want to get their lands opened up quickly and cheaply.

The Pekan Nanas Smallgrowers' Pineapple Co-operative Society has commenced operation and by the end of the first quarter it had made sufficient profit to make a first advance on a second lorry. It has also commenced purchase of manures for re-sale to its members.

Cloves and Nutmegs.

These two crops are grown on a small scale on Penang Island. The industry has been in a poor way during the past twenty years owing to severe pest attacks, but recently there has been a revival of interest, especially for cloves, and plantations are being replanted. Two spraying demonstrations, carried out by the Department in conjunction with the Shell Company, on the use of Dieldrin against clove borers have had a successful result, with one grower purchasing his own spraying equipment for regular use.

Prices of cloves during the quarter were $80 per pikul (133 1/3 lb.) wet and $280 per pikul dry.

Cacao.

In Trengganu, plans for opening the first of a series of pilot schemes throughout the Federation have been finalised. These pilot schemes are intended to introduce the crop to smallholders and to show them the correct method of developing and preparing the crop. The Rural and Industrial Development Authority (R.I.D.A.) has agreed to pay all costs of alienation, a daily assistance of $1.50 for each day the selected smallholder is engaged on the scheme and a loan of $600 for the purchase of planting material, fertiliser, fencing, etc. Twelve smallholders have been selected, six from the Federal Experiment Station, Jerangau, one from Jerangau Estate and five from Kampong Perak.

In Pahang, a similar pilot scheme is still in the planning stage. A new site near Kampong Kepayang, along the Maran road, has been selected but difficulty is being experienced in arranging suitable financial terms with R.I.D.A., as in this case the kampong people have no estate work to fall back upon.

Seed gardens set up by the Department in various States have met with varying success. The promising ones are at Batang Merbau in Kelantan and those along the Perak River. Those at Baling in Kedah, Sungei Buloh in Selangor, and at Ampang Tinggi and Petasseh in Negri

Sembilan are less promising; those at Sik in Kedah and Sungei Dendang in Perak are generally poor.

In Perak, observation plots established in many parts of the State have indicated that the Perak River area below Parit and parts of Upper Perak are probably suitable for cacao.

Some excellent cacao is growing under coconuts at Kuala Bernam in Lower Perak and also in Province Wellesley.

Livestock.

PIGS.

The price of pigs, both mature and weaners, dropped slightly during the quarter to approximately $85 per pikul for pigs ready for the butcher and $130 per pikul for weaners. The high prices of feeding stuffs—there were further rises during the quarter, especially for copra cake—have made things very difficult for those fattening pigs for the meat market.

The Middle White cross continues to gain in popularity and the Department in several States is unable to cope with the ever increasing demand for pure-bred boars. In Province Wellesley and Penang, where there are numerous local breeders of pure-bred stock, the Department has outstanding orders for 32 boars and 14 gilts.

At Cameron Highlands, the Department has supplied 26 boars and 37 gilts to Pahang, Penang, Johore and Perak during the quarter. In Johore, 69 services were performed by stud boars in new villages. There is an unsatisfied demand from this State, but the recent arrival of three pairs of new stock from the United Kingdom should go a long way to meeting this demand.

In Perak and Penang, the numerous pig-cum-fish farms continued to progress. A new centre was opened at Sungei Rotan, near Taiping, Perak, and comprises over four acres of fish ponds and some 50 pigs.

In Province Wellesley, some 1,000 weaner gilts were imported from Sitiawan, Perak. The majority of these went for fattening but 270 have been retained for breeding purposes. The Sitiawan gilt is regarded as a first class pig, its superiority no doubt being due to the fact that it has Large Black blood in it, the result of some old work of the Department which is still bearing fruit.

POULTRY.

From Johore comes the news that one of the local poultry-keepers (a R.I.D.A. protégé) is actually making money and is obtaining a gross return of $1,000 per month from his 115 White Leghorns and 500 local birds.

In Negri Sembilan, over 75 per cent of those granted poultry loans by R.I.D.A. have failed, mainly on account of lack of knowledge and ability to work hard and pay attention to detail.

The Department in Selangor, on behalf of themselves, Kedah, Kelantan, Trengganu, Pahang and Malacca, imported eggs of the following

breeds from the United Kingdom and Denmark:—Rhode Island Red, White Leghorn, New Hampshire Red and Light Sussex. These are being used to maintain the various demonstration pens and to supply good birds to local breeders.

In Kelantan and Johore, exchange systems are in operation whereby local farmers in selected areas can exchange their local cockerels for pure-breds. Some difficulty has been experienced in Johore over a fair exchange as, owing to the much larger size of the Rhode Island Red, a straight forward, one for one exchange does not work, but this has now been overcome by exchanging the pure-bred birds at a younger age. Altogether, some 70 cockerels and 80 pullets were exchanged in Johore and 56 in Ulu Kelantan new villages.

GOATS.

There does not appear to be any real or prolonged interest in goats. Although the imported goats have created favourable comment, there are few in this country who are prepared to give them the attention they deserve, or to make use of them for milk supplies.

From Johore comes the news that the 13/16 Saanan buck owned by the Penghulu Bakri performed 13 services during the quarter and the Departmental buck four services.

An undiagnosed disease killed 18 kids in Trengganu. Elsewhere, stock has been healthy, except for the usual poordoers.

Agricultural Education.

Successful extension work depends mainly on two important factors, (a) the professional ability of the technical staff, and (b) education of the rural peoples. The latter problem is probably the most difficult as it demands patience, enthusiasm and a flair for salesmanship, and these attributes are not often naturally found in combination with high technical skill.

Eight courses of short duration were organised in Selangor, Pahang and Perak during the quarter. The Selangor courses, of which there were five, were of a general nature and each was attended by 15 or 16 youths. The Pahang course was for 10 aboriginal ketuas (headmen) from the coastal mukims (parishes) of Ronpin and Keratong, while the two Perak courses were for two batches of six ex-Special Constables from Jeram Mengkuang and Kampong Balun.

Rural Training Centres were completed late in the year at Cherok To'kun in Province Wellesley, at Ayer Hitam, Johore, and at Kota Bharu in Kelantan: these will be ready for use early in 1956 and will extend the Department's teaching facilities considerably. The Training Centre at Cheras in Selangor has now been supplied with electric power and this will enable suitable films and slides to be shown.

Fruit tree budding demonstration and training courses were given at five Centres. Such demonstrations are usually popular and attract

quite large crowds, but it is only possible to train a few students at a time.

Assistance was given by officers of the Department at 15 Civics Courses.

Publicity campaigns have been carried out in most States in connection with the rubber replanting scheme, and these have shown some success in that the number of applications for 1956 is considerably greater than in past years.

Twenty-five padi planters from Assam Bubok in Johore made an educational tour of the padi areas of Tanjong Karang in Selangor and the Federal Experiment Station, Serdang. Such trips are of inestimable value as they are not only of considerable educational value to those participating in them but also promote interest amongst those they visit. Unfortunately, they are an expensive method of extension and full advantage of them can seldom be taken for financial reasons.

In Kelantan, 60 farmers from the Pergoh Valley of Ulu Kelantan, police officers, teachers and others attended five Field Days at Kota Bharu Agricultural Station. Similar educational tours were made by the Government English School, Segamat, Johore, to Tangkak Agricultural Station.

Also in Johore, a two-week buffalo training and ploughing course was organised for two trainees and their buffaloes from Kampong Lukot, a padi area where buffaloes have never been utilised for padi work.

In Province Wellesley, the padi courses for school students were re-started. Three courses were run for 24 students from English schools, 81 from Malay schools and 24 from Chinese schools. Considerable interest is taken in these courses.

Other activities have been the giving of lectures in Johore in connection with the Japanese padi film, which was shown at 11 centres; the giving of lectures on padi cultivation at eight centres in Kelantan; and, in Perak, at the request of the President of the Department of Religious Affairs, lectures on general agricultural subjects at the mosques after Friday prayers. It is reported that response to the lectures in Perak varies from the formation of discussion groups to complete lack of interest. Lectures are also given regularly to the R.I.D.A. School and the Rehabilitation Camp at Taiping in Perak.

In Province Wellesley, 12 demonstrations of chemical weed control using Agroxone 4 were given on cultivators' lands and were exceptionally successful.

Another success comes from Pahang where two ex-students of the Rural Training Centre, Pekan, have most successfully established a really first class rubber nursery in their fruit and coconut holding. Similar improved holdings and progressive farmers are to be found in Kedah (Haji Taib's holding at the 14th mile, Perlis Road) and in Selangor (Puasa bin Ismail's holding at Sungei Manis in the Kuala Langat district).

An Agricultural Show at Slim in Perak and a Sawah Competition in Segamat were held during the quarter.

The Service Bureaux being run at three centres in Kelantan continue to function well and serve as useful centres for the distribution of budded plants, rat poison, insecticides, etc. Provided increased transport facilities can be made available, it is hoped to open more of these centres next year.

Ex-Special Constable Schemes.

With very few exceptions, these unfortunately are not proving a success, mainly on account of lack of sufficient finance and lack of farming experience amongst the participants. One of the most successful schemes in the country is that at Kampong Stia (Kampong Traill) in Selangor. Here, buildings to complete the housing of 174 settlers were nearing completion and the earlier completed portion of the village is rapidly assuming the appearance of a settled kampong. Opening up of the main agricultural lots is progressing slowly and sufficient planting material for 150 acres has already been distributed. It is estimated that this scheme will be at least 50 per cent successful.

Departmental Notes

Honours and Awards.

The following officers were honoured by Her Majesty the Queen in the New Year's Honours List:—

Mr. J. L. Greig, Director of Agriculture, North Borneo, was appointed to be an Officer of the Order of the British Empire. Mr. Greig was a Senior Agricultural Officer in Malaya before going to North Borneo.

Enche Tak bin Haji Daud, Assistant Research Officer, was appointed to be a Member of the Order of the British Empire.

Enche Saidin bin Dain, Assistant Agricultural Officer, Negri Sembilan, has been awarded the Negri Sembilan Meritorious Service Medal.

Tuan Haji Abdul Wahid bin Haji Jaafar, Assistant Research Officer, has been awarded the Imperial Service Medal.

Retirement.

Tuan Haji Abdul Wahid bin Haji Jaafar, I.S.M,

Tuan Haji Abdul Wahid, Assistant Research Officer, retired from Government Service on the 31st December, 1955, after a period of service of over 38 years.

Tuan Haji Abdul Wahid was appointed as a Malay Probationer in March, 1917, and worked in Selangor under the Field Officer. In 1919 he was transferred to the Mycology Division, and after a few years there to the newly formed Plant Physiology Division, becoming the first Malay Officer in the new Division. He then worked on the problems of latex and rubber generally until rubber research was made the responsibility of the Rubber Research Institute of Malaya.

The Plant Physiology Division was eventually extended to become the Soils and Plant Physiology Division, and Tuan Haji Abdul Wahid became the Senior Malay Officer in this Division and was eventually promoted, in 1938, to the post of Assistant Research Officer, being the first officer in the Research Branch to hold that post.

Tuan Haji Abdul Wahid was held in the greatest respect by all with whom he came in contact and he carried out his work on the many and varied research problems with the utmost care and undaunted enthusiasm. He was interested in anything electrical or mechanical and his skill was often called upon to keep laboratory instruments in action.

He will be much missed by his colleagues in the Soils Division but in his retirement he carries with him the good wishes of all for his continued health and prosperity in practical farming, to which he is now devoting his energies.

It was announced on the 23rd February, 1956, that Her Majesty the Queen had awarded the Imperial Service Medal to Tuan Haji Abdul Wahid.

Promotions.

Mr. J. Cook, Senior Agricultural Officer, to be Chief Field Officer with effect from the 13th October, 1955.

Enche Mohd. Nor bin Haji Abdul Hamid, Agricultural Assistant, to be Assistant Agricultural Officer with effect from the 1st January, 1956.

Mr. S. Thamboo, Agricultural Assistant, to be Assistant Research Officer with effect from the 1st January, 1956,

Mr. L. N. H. Larter, Senior Botanist, to be Assistant Director (Research) with effect from the 9th January, 1956.

Appointments.

The Secretary of State for the Colonies has appointed Mr. G. I. M. Martin to be an Agricultural Officer in Malaya. Mr. Martin was appointed on the 25th November, 1955.

Mr. J. K. Coulter, Chemist (Soils), to act as Senior Chemist (Soils) with effect from the 25th November, 1955.

The Secretary of State for the Colonies appointed Dr. C. C. Webster to be Deputy Director of Agriculture, Federation of Malaya, with effect from the 12th January, 1956.

Mr. A. E. Billington, Senior Chemist, to act as Assistant Director (Research) with effect from the 28th January, 1956.

Mr. F, N. G. Conaty, Canning Officer, to act as Senior Chemist with effect from the 28th January, 1956.

Transfer.

Mr. J. Cook, Assistant Director (Field), was transferred on promotion to the post of Director of Agriculture, Sarawak, with effect from the 13th January, 1956.

Leave.

The following officers have returned from leave:—

Mr. J. K. Coulter, Chemist (Soils), on the 24th November, 1955.

Mr. T. R. Dickinson, Agricultural Officer, on the 23rd January, 1956.

Mr. P. Class, Agricultural Officer, on the 7th February, 1956.

Mr. L. N. H. Larter, Assistant Director (Research), proceeded on leave on the 28th January, 1956.

Change of Title.

With effect from the 1st January, 1956, the titles of the posts of Chief Field Officer and Chief Research Officer were changed to Assistant Director of Agriculture (Field) and Assistant Director of Agriculture (Research).

MARKET PRICES

October to December, 1955.

Rubber.—The quarter under review saw a decline in the Singapore price of R.S.S. No. 1, with monthly average prices at between 18 and 26 cents per lb. below the average for September.

The price (f.o.b. in bales, buyer) stood at 138.50 cents per lb. on the 1st October but had dropped to 116.875 on the 13th. There was an increase to 128.50 cents on the 19th October but by the end of the month the price was down to 118.625 cents. The average price for October was 124.79 cents per lb.

By the 4th November there had been a further reduction of just over 11 cents to 107.25 cents per lb. However, there was a revival, and on the 25th day the price was back to 130 cents. The average for November worked out at 121.28 cents per lb.

Prices were better in December, averaging 129.20 cents. Prices ranged from 126.375 to 135.75 cents per lb. The Market was closed on eight days in the month.

The average price of No. 1 R.S.S. in 1955 was 114.16 cents per lb., the highest average since 1951. The average price in 1954 was 67.29 cents.

The prices given above are the noon prices for rubber as reported by the Singapore Chamber of Commerce and they have been taken from the Monthly Statistical Bulletin of the Federation of Malaya.

The average prices paid for smallholders' rubber at three towns in the Federation of Malaya are given in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Smallholders' Rubber, October to December, 1955.

(Dollars per pikul of 133 1/3 lbs.)

Grades.	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Smoked Sheet No. 1	124.63	123.45	128.34	124.35	125.05	131.24	—	—	—
Unsmoked Sheet	103.11	102.27	110.29	93.52	91.86	98.47	105.64	107.28	110.35
Scrap	46.63	49.12	53.58	52.23	54.33	58.11	38.96	37.76	40.09

This Table has been compiled from statistics supplied by the Registrar of Statistics, Federation of Malaya.

Palm Oil.—The London prices for palm oil during the quarter were, in Malayan dollars per ton:—October 660.00; November 675.00; and December 662.14. The average London price for 1955 was $644.46 per ton.

The average price in London during the third quarter, 1955, for oil shipped by the Malayan Oil Palm Pool, f.o.b. ex-installation in Malaya was $627.97 per ton.

Tea.—The Registrar of Statistics, Federation of Malaya, reports that 1,329,530 lb. of made tea was produced during the quarter. Total production of made tea during 1955 amounted to 5,306,301 lb., 52 per cent of which was grown in the lowlands.

The average prices paid for Ceylon teas at the sale held in Colombo on the 20th December, 1955, were as follows, in rupees per lb:—High Grown Teas (4,000 ft. and above) 2.19; Medium Grown Teas (2,000 to 3,999 ft.) 1.77; Low Grown Teas (below 2,000 ft.) 2.10.

Derris.—The price of this commodity remained at $110 per pikul.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per pikul)

Date	Copra, Sundried	Coconut oil *	Pepper, F.A.Q. Muntok white	Pepper, Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1955								
3rd Oct. -	27.75	44.25	160.00	170.00	46.00	12.75	17.75	15.50
10th Oct. -	26.75	42.75	162.00	172.00	46.00	12.75	17.75	15.50
17th Oct. -	27.00	43.50	153.00	163.00	46.00	12.50	17.75	16.50
24th Oct. -	27.25	43.50	151.00	161.00	46.00	12.62½	18.00	16.50
31st Oct. -	27.25	43.25	140.00	150.00	46.00	12.62½	17.75	16.50
7th Nov. -	26.75	43.00	138.00	148.00	46.00	12.62	17.75	17.00
15th Nov. -	26.75	42.50	138.00	148.00	46.00	12.62½	17.50	17.50
21st Nov. -	26.75	40.00	134.00	144.00	46.00	12.62½	17.50	17.50
28th Nov. -	26.75	43.00	134.50	144.50	46.00	12.75	—	17.50
5th Dec. -	27.00	43.50	137.00	147.00	46.00	12.50	17.50	17.50
12th Dec. -	27.25	43.00	137.00	147.00	46.00	12.50	17.50	17.50
19th Dec. -	27.25	43.25	138.00	148.00	46.00	12.75	17.50	17.50
28th Dec. -	27.50	43.25	146.00	156.00	46.00	12.62½	17.50	18.00

* F.O.B. in second-hand drums.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA

PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1954	1955	1954	1955
January ..	4,143	4,093	1,139	1,124
February ..	3,908	3,997	1,066	1,081
March ..	4,442	4,854	1,210	1,300
April ..	4,674	4,630	1,228	1,221
May ..	5,251	4,152	1,396	1,076
June ..	4,188	5,135	1,114	1,256
July ..	4,580	4,802	1,162	1,238
August ..	4,694	5,128	1,236	1,348
September ..	4,319	5,073	1,157	1,269
October ..	4,333	4,855	1,154	1,262
November ..	4,642	4,952	1,273	1,348
December ..	4,776	4,820	1,336	1,366
Total ..	53,950	56,491	14,471	14,889

In December, 54 estates were in production out of a total of 61 oil palm estates.

MALAYAN AGRICULTURAL EXPORTS,

JULY—SEPTEMBER, 1955.

Product	Net Exports in Tons			
	Year 1953	Year 1954	July-Sept., 1954	July-Sept., 1955
Arecanuts	11,580	5,511	192 *	300
Coconuts, fresh † ‡	88,315 †	94,433 †	24,034 †	14,131 †
Coconut oil ‡	60,779	78,507	23,039	24,767
Copra ‡	9,751 *	67,472 *	24,723 *	24,064 *
Copra cake	59,129 *	40,520 *	5,171 *	17,501 *
Gambier, all kinds	160 *	134 *	9 *	8 *
Palm Oil	47,579	48,908	12,385	14,508
Pineapples, canned	17,368	21,533	7,195	8,401
Rubber ¶	572,792 ¶	582,991 ¶	159,741 ¶	166,144 ¶
Sago,—flour	28,444	27,980	5,156	4,815
Sago,—pearl	5,896	5,122	1,089	1,488
Sago,—raw	27,246 *	27,021 *	7,120 *	5,749 *
Tapioca,—flake	128 *	49	45	104
Tapioca,—flour — —	7,362 *	4,555 *	912 *	1,183 *
Tapioca,—pearl	5,474	7,865	1,980	1,093
Derris	10	16	4	1
‡ Copra equivalent	90,781	88,943	13,196	15,900

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1954	1955	1954	1955	1954	1955
January	30,278	29,260	19,014	26,033	49,292	55,293
February	25,354	28,497	17,913	21,928	43,267	50,425
March	24,556	27,465	17,452	24,874	42,008	52,339
April	24,749	24,155	15,339	20,415	40,088	44,570
May	27,572	27,355	18,585	22,331	46,157	49,686
June	26,873	27,497	16,236	22,841	43,109	50,338
July	30,970	30,238	22,931	25,647	53,901	55,885
August	30,826	30,650	21,576	23,571	52,402	54,221
September	30,067	31,274	23,371	24,764	53,438	56,038
October	29,405	30,724	20,724	23,960	50,129	54,684
November	31,798	30,174	22,925	21,743	54,723	51,917
December	30,313	34,893	24,164	27,174	54,477	62,067
Total	342,761	352,182	240,230	285,281	582,991	637,463
Total 1953	341,117		231,675		572,792	

This Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

Production on smallholdings (estates of less than 100 acres) is taken as the total of purchases from smallholders reported by licensed dealers.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates (a)		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955
January	3,123	2,674	9,470	4,297	12,593	6,971	8,837	5,528	5,583	3,561
February	2,789	2,797	9,616	8,366	12,405	11,163	7,798	7,753	4,891	4,808
March	3,072	2,975	11,482	7,726	14,554	10,701	8,721	7,368	5,487	4,603
April	2,993	3 021	9,922	7,478	12,915	10,499	6,961	6,165	4,515	3,934
May	3,803	3,619	10,128	7,630	13,931	11,249	8,098	7,399	5,195	4,580
June	3,763	3,748	12,175	10,534	15,938	14,282	8,158	8,017	5,181	5,128
July	4,112	3,955	11,850	12,311	15,962	16,266	8,582	8,538	5,505	5,400
August	3,886	4,188	11,237	10,275	15,123	14,463	8,480	8,580	5,489	5,370
September	3,481	3,745	10,631	9,511	14,112	13,256	8,501	9,259	5,403	5,749
October	3,069	3,591	11,160	9,730	14,229	13,321	8,014	9,240	5,184	5,787
November	2,942	2,850	8,854	8,486	11,796	11,336	7,296	9,059	4,602	5,758
December	2,831	3,301	7,770	7,180	10,601	10,481	7,354	8,050	4,533	5,062
Total	39,864	40,464	124,295	103,524	164,159	143,988	96,800	94,956	61,568	59,740

Notes:—1. The above Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

(a) Includes copra equivalent of sales of fresh nuts by estates.

METEOROLOGICAL SUMMARY, MALAYA, SEPTEMBER, 1955.

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	°F	°F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	92.1	72.2	82.1	95.0	69.0	89.0	74.0			8.85	224.8	3.70	18	11	2			200.60	6.69	
Kuala Lumpur, Selangor	89.7	72.5	81.1	92.4	69.2	86.7	75.5			10.93	277.6	2.54	19	15	10	5				
Sitiawan, Perak	89.2	72.5	80.9	91.5	68.2	85.8	75.0	84.0	85.4	4.66	118.4	1.93	12	9	5	4		190.90	6.36	
Kuantan, Pahang	89.0	71.4	80.2	91.6	68.9	82.6	74.0	83.1		6.09	154.7	1.38	12	9	6	4		193.10	6.44	
Bayan Lepas, Penang	86.9	74.1	80.5	90.1	70.2	79.2	77.8			13.72	348.5	4.70	21	19	5			198.60	6.62	
Malacca	87.4	73.0	80.2	90.1	70.7	85.0	75.8			11.36	288.5	3.78	18	13	2	2		197.35	6.58	
Mersing, Johore	86.7	70.9	78.8	90.6	68.4	79.4	73.4			5.02	127.5	1.35	16	14			1	182.10	6.07	
Alor Star, Kedah	88.5	73.2	80.9	92.6	70.7	80.8	74.8			4.09	103.9	0.96	19	14				216.30	7.21	
Kota Bharu, Kelantan	88.9	73.6	81.3	91.8	71.2	84.1	76.0	86.8	88.1	4.64	117.9	2.41	10	9				231.10	7.70	
K. Trengganu, Trengganu	88.9	72.3	80.6	92.0	69.4	85.0	75.0			1.92	48.8	1.26	4	4				224.00	7.47	
Singapore	86.7	74.2	80.5	90.3	71.1	81.0	76.8			5.70	144.8	2.91	16	15	3	2		143.15	4.77	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	73.1	53.4	63.3	75.0	48.0	69.0	60.0			7.77	197.4	2.42	15	15				135.85	4.52	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, OCTOBER, 1955.

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	91.1	72.7	81.9	95.6	68.4	86.0	74.8			13.12	333.2	2.29	22	21	1			200.05	6.45	
Kuala Lumpur, Selangor	89.1	72.6	80.9	92.9	69.8	82.2	76.2			11.78	299.2	2.43	21	18	11	5				
Sitiawan, Perak	89.3	72.7	81.0	93.9	70.0	85.8	75.4	84.3	85.6	6.85	174.0	1.77	16	11	2	1		190.90	6.16	
Kuantan, Pahang	88.0	71.8	79.9	92.4	69.1	78.9	75.6	82.8		11.71	297.4	2.81	21	18	10	4		163.25	5.27	
Bayan Lepas, Penang	86.7	74.0	80.3	89.8	71.7	82.6	75.8			14.10	358.1	2.35	21	20	5			177.55	5.73	
Malacca	87.1	72.9	80.0	90.0	70.5	81.0	74.9			15.54	394.7	4.61	21	19				192.70	6.22	
Mersing, Johore	86.9	71.2	79.1	92.9	69.8	79.0	73.8			6.29	159.8	2.00	15	14				180.20	5.81	
Alor Star, Kedah	87.0	73.5	80.3	90.2	70.4	74.9	75.6			16.90	429.3	2.61	24	20	1	2		149.40	4.82	
Kota Bharu, Kelantan	85.8	73.8	79.8	90.7	69.0	78.1	76.9	84.2	86.9	15.93	404.6	2.45	26	22	10	1		149.70	4.83	
K. Trengganu, Trengganu	86.1	72.7	79.4	90.4	70.6	78.7	74.7			16.75	425.5	2.47	24	23				170.80	5.51	
Singapore	86.9	74.1	80.5	91.4	72.0	79.5	76.5			7.85	199.4	2.18	19	15	6	2		167.35	5.40	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	72.9	—	—	78.0	—	68.0	—			16.10	408.9	3.81	23	23				123.25	3.98	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, NOVEMBER, 1955.

Locality	Air Temperature Degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes				At 1 foot	At 4 feet	Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	°F	°F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										in.	mm.	in.						hr.	hr.	
Ipoh, Perak	89.5	72.3	80.9	95.2	69.6	83.9	75.2			11.53	292.9	2.03	22	18	2			163.30	5.44	
Kuala Lumpur, Selangor	88.0	72.7	80.3	92.4	70.0	83.0	74.9			11.68	296.7	2.31	19	7	7	6				
Sitiawan, Perak	87.8	72.3	80.1	92.1	69.1	83.3	75.1	83.3	84.9	5.17	131.3	1.06	20	2	1	1		184.90	6.16	
Kuantan, Pahang	86.5	72.2	79.3	92.6	69.8	77.5	75.0	81.9		7.56	192.0	1.75	25	16	6	7		119.65	3.99	
Bayan Lepas, Penang	85.4	73.3	79.3	90.5	70.9	79.1	76.2			11.19	284.2	1.59	22	21	1			146.45	4.88	
Malacca	87.4	73.1	80.3	90.4	71.5	82.0	75.0			8.53	216.7	1.69	19	17				145.30	4.84	
Mersing, Johore	85.3	72.1	78.7	90.9	70.4	76.3	74.1			8.11	206.0	1.59	20					147.85	4.93	
Alor Star, Kedah	85.9	72.6	79.3	91.6	67.6	79.3	76.4			11.20	284.5	1.58	23	21				134.00	4.47	
Kota Bharu, Kelantan	84.1	73.4	78.7	89.0	71.0	76.2	75.9	81.4	84.0	21.49	545.8	5.52	24	18	6			110.90	3.70	
K. Trengganu, Trengganu	84.4	72.4	78.4	89.0	69.0	74.5	75.5			32.35	821.7	7.27	20	18			1	144.50	4.82	
Singapore	86.6	74.1	80.3	91.2	70.8	80.0	77.7			6.50	165.1	2.65	17	16	7	1		136.10	4.54	
HILL STATION																				
Cameron Highlands, Tanah Rata, Pahang. (4750 ft.)	71.8	56.1	63.9	76.0	47.0	65.0	61.0			14.04	356.6	2.31	23	23				95.30	3.18	

Compiled from Returns supplied by the Malayan Meteorological Service.